U.S. DEPARTMENT OF COMMERCE
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PB-300 323

Lower Meramec River Basin Wastewater Treatment Facilities St. Louis, Missouri. Volume I

(U.S.) Environmental Protection Agency, Kansas City, MO

11 Jul 79

PB 300323

EPA-907/9-79-004a

EPA-7-MO-ST. LOUIS-
ST. LOUIS COUNTY-
WWTP-79

FINAL
ENVIRONMENTAL IMPACT STATEMENT
LOWER MERAMEC BASIN

Volume I

MSD

Metropolitan St. Louis Sewer District
St. Louis, Missouri

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Region VII - Kansas City, Missouri

BIBLIOGRAPHIC INFORMATION

PB-300 323

Lower Meramec River Basin Wastewater Treatment Facilities, St. Louis, Missouri. Volume I.

11 Jul 79

PERFORMER: Environmental Protection Agency, Kansas City, MO. Region VII.
EPA/907/9-79/004A

Prepared in cooperation with Metropolitan St. Louis Sewer District, MO., and Ryckman, Edgerley, Tomlinson and Associates, Inc., St. Louis, MO. See also Draft rept., PB-289 948.Color illustrations reproduced in black and white.

The subject action of this Environmental Impact Statement (EIS) is the approval of the Facilities Plan prepared in accordance with Section 201 of the Federal Water Pollution Control Act of 1972, as amended (P.L. 92-500) by the Metropolitan St. Louis Sewer District. Pursuant to the National Environmental Policy Act of 1969 (P.L. 91-190), the Environmental Protection Agency (EPA) has prepared this EIS to evaluate the potential impacts of this proposed action upon the Lower Meramec River Basin and the Metropolitan St. Louis area. The project study area includes both the St. Louis and Jefferson County portions of the Meramec River Basin and its watershed areas from the vicinity of Ellisville to the Mississippi River. In 1975 the Lower Meramec River was classified by the Missouri Department of Natural Resources as 'water quality limited' because of severe pollution problems associated with rapid urban growth in the area within the last decade. The Lower Meramec River also serves as a source of potable water for southern St. Louis County and as an areawide recreation re

KEYWORDS: *Environmental impact statements-final, *Sewage treatment, *Meramec River Basin.

Available from the National Technical Information Service, Springfield, Va. 22161

PRICE CODE: PC A09/MF A01

EPA-907/9-79-004a

EPA-7-MO-St. Louis
St. Louis County - WWTP-79

FINAL ENVIRONMENTAL IMPACT STATEMENT

For The Proposed

LOWER MERAMEC RIVER BASIN WASTEWATER TREATMENT FACILITIES

St. Louis, Missouri

Prepared by

U.S. Environmental Protection Agency, Region VII

Kansas City, Missouri

With Technical Assistance by

Ryckman/Edgerley/Tomlinson & Associates, Inc.

St. Louis, Missouri

COLOR ILLUSTRATIONS REPRODUCED
IN BLACK AND WHITE

APPROVED BY:

7/11/79

for Kathleen Q. Camin, Ph.D. Date
Regional Administrator

SUMMARY

LOWER MERAMEC RIVER BASIN WASTEWATER TREATMENT FACILITIES

( ) Draft (X) Final

Responsible Office: U.S. Environmental Protection Agency, 1735 Baltimore, Kansas City, Missouri 64108, telephone 816/374-2921.

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Proposed Action: The subject action of this Environmental Impact Statement (EIS) is the approval of the Facilities Plan prepared in accordance with Section 201 of the Federal Water Pollution Control Act of 1972, as amended (P.L. 92-500) by the Metropolitan St. Louis Sewer District. Pursuant to the National Environmental Policy Act of 1969 (P.L. 91-190), the Environmental Protection Agency (EPA) has prepared this EIS to evaluate the potential impacts of this proposed action upon the Lower Meramec River Basin and the Metropolitan St. Louis area.

The project study area includes both the St. Louis and Jefferson County portions of the Meramec River Basin and its watershed areas from the vicinity of Ellisville to the Mississippi River. In 1975 the Lower Meramec River was classified by the Missouri Department of Natural Resources as "water quality limited" because of severe pollution problems associated with rapid urban growth in the area within the last decade. The Lower Meramec River also serves as a source of potable water for southern St. Louis County and as an areawide recreation resource.

3. Environmental Impacts: Each of the alternative treatment techniques is described in terms of its potential impact on the environment. All of the alternatives, except the "no action" alternative, will improve the water quality in the study area. Primary and secondary impacts will occur, however, and are summarized as follows:

Primary

a. Pre-emption of land for the sewage treatment plant, sludge-disposal lagoons, and permanent access shafts.
b. Terrain disturbance during construction, with accompanying loss of biological habitat, increased erosion and siltation, and aesthetic degradation.
c. Short-term construction noise impacts to some residents and in some recreational areas.
d. Some interruption of recreational pursuits during construction carried out in recreational areas.

Secondary

a. Increased ambient noise levels accompanying increases in density of development and vehicular traffic.
b. Decrease in air quality accompanying development and increased traffic.
c. Increased urban storm runoff and subsequent addition of increased hydrocarbons and phenols to project area waters.
d. Increased pressures on the area's biological and archaeological resources including the loss of terrestrial biological habitat and some archaeological resources during development.
e. An increase in taxes to individuals now living in the project area for services to support the projected increase in population. The additional population projected to accompany the proposed improvements will require an increase in public support services such as schools, fire and police protection, utility services, and medical facilities.

4. Alternatives: The following project alternatives are discussed in this statement:

a. No action.
b. A subregional wastewater system with nine plants located near the mouths of the Keifer, Williams, Fishpot-Grand Glaize, Mattese, Fenton-Yarnell, Pomme, and Sugar Creeks and in drainages designated Meramec Subareas III and VI. Under this plan, tertiary treatment would be carried out with discharge to the Meramec. Sludge disposal would be by on-site lagooning.
c. A regional wastewater system with a single regional plant near the mouth of the Meramec which would treat wastewaters to a secondary-level with discharge to the Mississippi. Sludge disposal would be by on-site lagooning. Two alternate conveyance systems will be evaluated under this plan: Trunk line by open-cut construction; and trunk line by tunnel construction.

5. Date Available to the Public:

6. Comments Requested:

Federal Agencies

U.S. Department of Agriculture
    Agricultural Stabilization and Conservation
    Soil Conservation Service
    Forest Service
U.S.Department of Defense
    Army Corps of Engineers
U.S. Department of Health, Education and Welfare
U.S.Department of Housing and Urban Development
U.S.Department of the Interior
    Fish and Wildlife Service
    National Park Service
    Geological Service
    Heritage Conservation and Recreation Service

U.S. Department of Transportation
    Federal Aviation Administration
    Federal Highway Administration
Advisory Council on Historic Preservation
U.S. Department of Energy
    Federal Energy Administration

Members of Congress

John C. Danforth, U.S. Senate
Thomas F. Eagleton, U.S. Senate
William L. Clay, U.S. House of Representatives
Richard A. Gephardt, U.S. House of Representatives
Robert A. Young, U.S. House of Representatives

State

Department of Agriculture
Department of Conservation
Department of Natural Resources
    Division of Planning and Policy Development
    Division of Geology and Land Survey
    Division of Environmental Quality
    Division of Parks and Recreation
Soil and Water Districts Commission
Missouri Cooperative Fishery Research Unit
Missouri State Historical Society

Local and Regional

City of St. Louis
City of Arnold
City of Fenton
City of Manchester
City of Valley Park
City of Ballwin
City of Ellisville
City of Kirkwood
City of Peerless Park
City of Sunset Hills
City of Twin Oaks
City of Town and Country
City of Winchester
East-West Gateway Coordinating Council
St. Louis County Department of Parks and Recreation
St. Louis County Department of Planning
Jefferson County Department of Planning
St. Louis County Department of Health
Jefferson County Department of Health

Interested Groups

National Audubon Society of Missouri
Sierra Club-Ozark Chapter
Open Space Council-St. Louis Region
St. Louis Community Development Agency
The Nature Conservancy-Missouri Chapter
League of Women Voters-St. Louis Chapter
Ozark Wilderness Waterways Club
American Camping Association-St. Louis Section
Coalition for The Environment
Meramec Community College
Meramec Basin Association
Clean Earth Society
Environmental Response
Upper Mississippi River Conservation Committee
Missouri Botanical Gardens
American Rivers Conservation Council
The Conservation Foundation
Ducks Unlimited, Inc.
The Environmental Law Institute
Friends of The Earth
The Izaak Walton League
National Wildlife Federation
Soil Conservation Society of America
The Trust for Public Land
Wetlands for Wildlife, Inc.
The Wilderness Society
The Wildlife Society-Missouri Chapter
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TABLE OF CONTENTS

Page No.

Letter of Transmittal i
Title Page ii
Table of Contents iii
List of Tables vi
List of Figures xi

Chapter No.

1 SUMMARY 1

Background 1
Alternatives 2
Comparison of Impacts of Alternate Systems 3
Recommended Plan 3
Impacts of Recommended Plan 5

2 INTRODUCTION 6

Background and History 6
Problem Description 7
Environmental Goals and Constraints 8
Necessity, Purpose, and Methodology of Environmental Impact Statement 9
Public Participation 10
Agencies Involved 11

3 ENVIRONMENTAL SETTING 13

Introduction 13
Location 16
Climate 16
Land Resources 20
Land Use 39
Water Resources 76
Air Quality 103
Biological Resources 115
Social Environment 135

4 ALTERNATIVES 144

Introduction 144
Constraints and Assumptions 144

TABLE OF CONTENTS
(Continued)

Chapter No.		Page No.
4	Discussion of Alternative Approaches to Wastewater Management	146
	Screening of Alternative Approaches to Wastewater Management	149
	Preliminary Screening of Alternative Wastewater Management Systems	151
	Screening of Alternative Wastewater Treatment and Sludge Processing and Disposal Approaches	154
	Conclusions	161
5	ENVIRONMENTAL IMPACTS OF THE VIABLE PROJECT ALTERNATIVES	173
	Noise Impacts	174
	Air Quality Impacts	179
	Impacts on Water Quality	192
	Impacts on Geology and Groundwater	232
	Biological Impacts	243
	Land Use Impacts	274
	Economic Impacts	280
	Impacts on Recreation	281
	Impacts on Cultural Resources	290
	Floodplain Impacts	296
6	SELECTED ALTERNATIVES	299
	Overall Systems	299
	Systems of Wastewater Treatment	300
	Systems of Sludge Management	302
	Treatment Plant Site Selection and Flood Protection Alternatives	307
	Project Phasing and Interim Wastewater Management	308
7	UNAVOIDABLE IMPACTS	314
	Secondary Impacts	314
	Primary Impacts	315
8	LOCAL SHORT-TERM USES OF THE ENVIRONMENTAL VS. MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY	317

TABLE OF CONTENTS
(Continued)

Chapter No.		Page No.
9	IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES LIKELY TO RESULT FROM IMPLEMENTATION OF THE PROPOSED PROJECT	322
10	PUBLIC PARTICIPATION	324
11	SIGNIFICANT ISSUES TO BE RESOLVED	438
	LIST OF REFERENCES	440
	GLOSSARY	450
	APPENDIX A	A1
	APPENDIX B	B3
	APPENDIX C	C1

LIST OF TABLES

Table No.		Page No.
1	Municipalities Included in the Lower Meramec River Basin Study Area	16
2	Normals, Means and Extremes	18
3	Generalized Stratigraphic Column for St. Louis and Jefferson Counties, MO	24
4	Geological Engineering Considerations - Lower Meramec Valley	34
5	Existing Land Use in the Lower Meramec River Basin - 1970	40
6	Urban Land Use in Jefferson and St. Louis Counties, MO	43
7	Local Manufacturing Characteristics of Selected Communities in the Lower Meramec River Basin	45
8	Educational, Health and Religious Facilities in Communities of the Lower Meramec River Basin	46
9	Number and Acreage of Outdoor Recreation Facilities by Type of Administration and Type of Ownership	48
10	Principal Recreation Areas in Region Directly Influenced by Alternate Project Activities	50
11	Recreation Inventory by County - 1970	53
12	Parks and Facilities in the Lower Meramec River Basin	54
13	Campground Facilities Located in the Lower Meramec River Basin	57
14	Farm Characteristics of Crop Production, Jefferson County, MO - 1959, 1964, 1969	62
15	Farm Characteristics of Crop Production, St. Louis County, MO - 1959, 1964, 1969	63

LIST OF TABLES
(Continued)

Table No.		Page No.
16	Agricultural Uses, St. Louis and Jefferson Counties 1959-1969	64
17	Mineral Production in the Meramec Basin 1969	65
18	Total Acreage of Woodland on Farms 1959, 1964, 1969	66
19	Net Timber Volume of Live Merchantable Sawtimber Trees - 1963	67
20	Projected Land Use in the Lower Meramec River Basin 1980 and 1995	70
21	Proposed Recreation Facilities in the Lower Meramec River Basin	72
22	Municipal Services	75
23	Water Quality Data (Jefferson Barracks Bridge)	78
24	Frequency/Discharge Analysis Meramec River 1967-1974	80
25	Low Flow Frequency Data Meramec River Near Eureka, MO	81
26	Wastewater Flow for Watersheds - 1970	82
27	Water Quality - Meramec River and Tributaries	86
28	Ammonia Nitrogen Concentrations	88
29	Summary of Well Data for the Valley Park Alluvial Aquifer	90
30	Summary of Available Water Quality Data from Wells in the Study Area	97
31	Water Consumption	100

LIST OF TABLES
(Continued)

Table No.		Page No.
32	Total Pollutant Emissions, Jefferson and St. Louis Counties, 1976	108
33	Significant Air Pollutant Point Sources in the Study Area, 1976	110
34	Mean Mixing Heights and Wind Speeds, St. Louis, MO	113
35	Vegetative Associations of the Lower Meramec River Basin	117
36	Typical Mammals of the Lower Meramec River Basin	120
37	Typical Reptiles and Amphibians of the Lower Meramec River Basin	121
38	Typical Birds of the Lower Meramec River Basin	122
39	Species of Fish Taken by Electroshocking Lower Meramec River Stations 1 and 2, June 1971	131
40	Fishes Collected in the Lower Meramec River Stations M-11 and L, July 1963	132
41	Population and Educational Characteristics Jefferson and St. Louis Counties, MO 1970	137
42	Study Area Population Income 1970 and Projected	138
43	Estimated Number of Dwelling Units by Watershed Basin, 1970	139
44	Ranking of Secondary Treatment Process Alternatives	158
45	Cost Comparison of Action Alternatives	169
46	Anticipated Noise Levels Subregional Plan	175

LIST OF TABLES
(Continued)

Table No.		Page No.
47	Anticipated Noise Levels	178
48	Description of Model Reaches in the Lower Meramec Study Area	196
49	Tributary Areas to the Lower Meramec Study Area	197
50	Untreated Wastewater Characteristics, Summer Conditions	203
51	Seepage Rates	240
52	Habitat Disturbed by Construction Under Alternate Plans	247
53	Potential Impacts of Project Activities on Habitat Types in the Project Area	261
54	Impacts of Alternative Plans on Terrestrial Ecosystems	262
55	Comparison of Aquatic Parameters	271
56	Demographic and Land Use Projections Under Regional, Subregional and No Action Options - Year 2000	277
57	Comparison of Estimated Land Requirements for Treatment Plants Under Selected Alternatives Acreage in Year 2000	278
58	Ranking of Impacts Under Alternate Total Systems	301
59	Comparison of Flood Protection Alternatives for Main Plant	308
60	Selected Alternative - Summary	309

LIST OF TABLES
(Continued)

Table No.		Page No.
61	Project Implementation Plan by Subwatershed	311
62	Long-Term vs. Short-Term Impacts	318
63	Predicted Water Quality Under Alternate Control Strategies - Year 2000	321

LIST OF FIGURES

Figure No.		Page No.
1	Study Area	14
2	Location Map	15
3	Annual Wind Direction Frequency Distribution	21
4	Annual Wind Speed Frequency Distribution	22
5	Monthly Mean Wind Speeds	23
6	Generalized Geologic Map	26
7	Thickness of Alluvium Along Mississippi, Missouri, Meramec and Lower Big Rivers and Some Tributary Streams	30
8	Hydrogeologic Sections	31
9	Major Structural Features	33
10	Topographic Regions	35
11	Soils Interpretation Map - Lower Meramec River Basin	37
12	Existing Land Use	41
13	Principal Recreation Sites	51
14	Major Transportation Routes	59
15	1995 Land Use Plan - Lower Meramec River Basin	68
16	Major Potential Recreation Areas - Lower Meramec River Basin	71
17	Major Improvements and New Construction Planned for 1995 - Lower Meramec River Basin	74
18	Discharge - Duration Curve at St. Louis Gage, 1955-1968	77

LIST OF FIGURES
(Continued)

Figure No.		Page No.
19	River Bed Profiles - 1944 and 1973	83
20	Flood-Frequency Curve For Meramec River Near Eureka, MO	85
21	Potentiometric Surface - Alluvial Aquifer - Valley Park Area	92
22	Distribution of Chloride in Alluvial Deposits in the Valley Park - Kirkwood Area	94
23	Distribution of Chloride Ion Concentrations in Mississippian and Pennsylvanian Aquifer	95
24	Distribution of High Iron Concentrations	96
25	Location of Wells	98
26	Air Quality Monitoring Stations	106
27	Major Point Sources of Air Pollutants	112
28	Wetland Habitat Areas - Lower Meramec River Basin	116
29	Locations of Aquatic Biological Collection Stations	129
30	1971 Pumpage Records South County Plant, St. Louis County Water Company	142
31	Subregional Alternative	163
32	Regional Alternative - Open Cut Conveyance	165
33	Regional Alternative - Tunnel Conveyance	167
34	Projected VMT in the Proposed Project Area, Millions of Miles Per Day	181

LIST OF FIGURES

Figure No.		Page No.
35	Projected Industrial Land Use	183
36	Proposed Project Area Population Projections	184
37	1975 Carbon Monoxide Emissions and Projections	185
38	Particulate Emissions and Projections	186
39	Sulfur Dioxide Emissions and Projections	187
40	Oxides of Nitrogen 1975 Emissions and Projections	188
41	1975 Hydrocarbon Emissions and Projections	189
42	Lower Meramec Study Area Reaches and Tributary Area	195
43	Meramec River Discharge at Eureka Gage	199
44	Mississippi River Discharge at St. Louis Gage	200
45	Daily Precipitation Pattern at St. Louis International Airport	201
46	Fecal Coliform Variations July 18, 1973	205
47	Temperature Variations July 18, 1973	206
48	TDS Variations July 18, 1973	207
49	BOD Variations July 18, 1973	208
50	DO Variations July 18, 1973	209

LIST OF FIGURES

Figure No.		Page No.
51	Ammonia Variations July 18, 1973	210
52	Nitrate Variations July 18, 1973	212
53	PO_4 Variations July 18, 1973	213
54	Chlorophyll-A Variations July 18, 1973	214
55	Fecal Coliform Variations Wet Weather Conditions July 24, 1973	215
56	Impact of a Rainfall Event - Flow	216
57	Impact of a Rainfall Event - TDS	217
58	Impact of a Rainfall Event - BOD	218
59	Impact of a Rainfall Event - DO	219
60	Impacts of a Rainfall Event - Chlorophyll-A	220
61	Impacts of a Rainfall Event - Fecal Coliform	221
62	BOD Variation Wet Weather Conditions July 24, 1973	223
63	DO Variations Wet Weather Conditions July 27, 1973	224
64	PO_4 Variations Wet Weather Conditions July 24, 1973	225
65	Chlorophyll-A Variations Wet Weather Conditions July 24, 1973	226

LIST OF FIGURES

Figure No.		Page No.
66	Typical Trench Cross Section: Open Cut Alternative	234
67	Conveyance Sewer Profile Alternate 1 - Open Cut	235
68	Conveyance Sewer Profile Alternate 2 - Tunnel Method	241
69	Terrestrial Habitat Types	245
70	Terrestrial Habitat Types Subregional Alternative	249
71	Terrestrial Habitat Types Regional Alternative Open Cut Conveyance	251
72	Terrestrial Habitat Types Regional Alternative Tunnel Conveyance	253
73	Principal Recreation Sites Subregional Alternative	283
74	Principal Recreation Sites Regional Alternative - Open-Cut Conveyance	285
75	Principal Recreation Sites Regional Alternative - Tunnel Conveyance	287

CHAPTER 1

SUMMARY

This document presents an analysis of the 201 Facilities Plan for wastewater management in the Lower Meramec River Basin in terms of environmental parameters. It is an informational document intended to provide the public and concerned agencies with an objective evaluation of the plan which they can use in making decisions regarding the proposed project. In keeping with a policy of full disclosure, those preparing the document have attempted to include sufficient data to explain each concept discussed, with sufficient brevity for reasonably manageable reading, and in terms which are understandable to those not having technical training in the disciplines from which the concepts were derived. Those technical terms which are used are defined in a glossary.

This chapter summarizes this Environmental Impact Statement (EIS). It is presented to aid the reader in assimilating the voluminous material presented in this report and to present the context in which subsequent chapters were prepared.

BACKGROUND

Description of Study Area

The project study area includes both the St. Louis and Jefferson County portions of the Meramec River and its watershed areas from the vicinity of Ellisville to the Mississippi. For brevity, the Meramec River and the Mississippi River will be termed "the Meramec" and "the Mississippi" in this EIS. Immediately to the north is the City of St. Louis, which strongly influences development and growth in the study area. About 26 percent of the land is developed, with approximately 23 percent in residential use. Most of the undeveloped acreage is in second-growth native timber.

Water Quality Problems

The Lower Meramec serves as an areawide recreation resource and a source of potable water for southern St. Louis County. Recent rapid growth in the watersheds of certain study-area tributaries in which wastewater treatment is no longer adequate has resulted in severe water pollution in those tributaries and the Lower Meramec itself. In May, 1970, the Missouri Water Pollution Board (now the Clean Water Commission) placed a construction ban on two of the tributary watersheds. In 1975, when pollution problems in the area became more evident, the lower Meramec River was classified by the Missouri Division of Environmental Quality as a "water quality limited stream segment". This classification is applied to a stream segment in which water quality does not meet applicable standards and is not expected to reach those standards even if secondary treatment for all point source discharges were applied.

201 Goals

The overriding goal of the 201 program is to provide a plan for wastewater management facilities which will help to upgrade the study area's streams to acceptable standards. The recommended plan should also be cost-effective, under the control of a designated responsible agency, adequate in capacity for present and projected needs, and environmentally acceptable.

ALTERNATIVES

Several alternate approaches to providing wastewater treatment service to the project area were considered at the inception of the planning process. These approaches included upgrading of existing facilities, individual home treatment, and areawide wastewater management. Due to several constraining characteristics of the area's environment (notably, steep topography and thin soils) and the condition, both physical and jurisdictional, of existing facilities, the approach recommended was areawide wastewater management.

Numerous alternative plans within this general approach were studied largely on the basis of technical feasibility in achieving pollution control goals. Subsequent to these studies, those alternatives remaining in consideration were compared in terms of cost-effectiveness. The studies showed two of the alternatives to be clearly superior to other alternatives considered: 1) a subregional system with treatment plants at tributary mouths, which would provide tertiary level treatment for discharge to the Meramec, and 2) a regional system with a single treatment plant near the mouth of the Meramec, which would provide secondary level treatment. The second alternative would require a main trunk conveyance line for economically feasible transport of wastewaters to the regional plant. Two alternative conveyance systems were studied; a trunk constructed by conventional cut-and-cover methods and one constructed by deep-rock tunneling.

COMPARISON OF IMPACTS OF ALTERNATE SYSTEMS

These three alternate systems, and the no action alternative, were analyzed in terms of the environmental impacts of construction and implementation. Parameters considered were water quality, noise, air quality, effects on biota, recreation resources, cultural resources, geology and groundwater, and socieconomic factors. Both beneficial and adverse impacts were considered. The regional system with tunnelled main-trunk conveyance was shown to be the best of the alternatives in terms of the greatest long-term benefits and the least long-term adverse impacts and was recommended as the optimum system for the 201 project. Mitigating measures are recommended to decrease the short-term impacts associated with the plan.

RECOMMENDED PLAN

Within the concept of a regional system with tunneled main-trunk conveyance, alternate methods of wastewater treatment, sludge management, and main-plant flood protection were studied. The principal methods considered and the primary reasons for their rejection or selection are as follows:

Wastewater Treatment Concepts

Land Application of Wastes - Rejected for lack of suitable land in project area and climatic conditions, which would necessitate large storage capacities.

Treatment and Re-use - Rejected for lack of economic feasibilty in project area.

Treatment for Discharge to Receiving Waters - Recommended for project on both economic and environmental bases; Mississippi chosen over Meramec as a receiving stream because of greater assimilative capacity. This capacity, in combination with the stream classification of the Mississippi, permits the discharge of wastewaters treated to secondary level.

Wastewater Treatment Methods

Numerous alternate methods of achieving the necessary levels of treatment for the project were investigated on the basis of costs, resource requirements, reliability, complexity, flexibility, and environmental considerations. These included both physical-chemical and biological methods. The method recommended on the basis of these analyses is biological treatment by activated sludge with step aeration.

Sludge Management, Processing and Disposal

Processing - The principal alternative methods considered for converting treatment sludge to a form suitable for lagooning and the major reasons for their rejection or selection are as follows:

1) Sludge reduction - Rejected due to great expense and relatively small quantities of sludge involved.

2) Sludge dewatering - Rejected as unnecessary and even counterproductive in a lagoon disposal system.

3) Sludge conditioning - Elutriation was rejected because it would not effect any desirable conditioning for a lagooning system. Heat treatment was rejected for its expense, potential problems with concentrated cooking liquors, and the lack of need for sophisticated dewatering prior to lagooning. Chemical conditioning is recommended for its flexibility, relatively low capital costs, and low energy consumption.

Disposal - Five methods of sludge disposal were evaluated for project applicability: land application, land reclamation, landfilling, power generation, and lagooning. The first three were eliminated due to the lack of suitable sites. Power generation was judged not to be economically feasible on the small scale involved. Lagooning was recommended on the basis of current successful use in the area, adequate available area, and compatibility with ultimate disposal by land application at a later date.

Lagooning of sludge would be very compatible with ultimate disposal of the sludge by land application. If lagoons having a large enough capacity for many years' sludge production were used, this would provide time for the sludge to thoroughly stabilize prior to possible removal for application to land. Sludge could be allowed to accumulate, and then removed at whatever time of year the conditions for land application were most favorable. Total land area requirements, which are usually governed by the need to avoid an excessive loading rate of nitrogen from the sludge, would be reduced by the tendency of the sludge to lose nitrogen to the atmosphere while detained in lagoons. Even if the land application operation were not conducted on a scale sufficiently large to utilize all of the sludge produced by the treatment plant, it would serve to extend the life of the lagoons farther into the future.

A comprehensive solids management study for the entire Metropolitan St. Louis Sewer District is currently being performed by Havens and Emerson, Inc. under a separate 201 Facilities Plan. Since the results of this study will directly affect the disposition of sludge from the project under study in this EIS, the Scope of Work for the solids management study is presented in Appendix C.

The recommended plan also includes an elevated berm for flood protection at the regional treatment plant and a phased construction system.

Under the phased system the main trunk would be constructed in stages beginning at the regional treatment plant and commencing upstream. Watershed sewer systems would be connected as the trunk "reaches" them. Interim facilities would serve each watershed until it was connected to the regional system. The regional treatment plant, with an ultimate design capacity of 40 million gallons per day (MGD), would be installed in four separate 10 MGD modules. These modules would be "brought on line" in coordination with the connection of watersheds to the main trunk.

IMPACTS OF RECOMMENDED PLAN

Although the recommended plan is considered to be the optimum plan for providing sewerage treatment to the study area with a minimum of environmental degradation, some unavoidable "costs" are associated with it. Chief among these are construction impacts, capital expenditures, and land use changes which would be facilitated by the project. These "costs" are discussed in Chapters 5 through 9 of this EIS, along with the long-term benefits to be derived from the project.

A general overview of the project's effects, as developed in those chapters, might be stated as follows: the provision of improved sewer service is judged to be necessary in order to continue using the area's resources for the benefit of the public. The proposed project would provide this service and help to protect the quality of the area's water resources. Implementation of the project would, however, require the commitment of both financial and physical resources. The extent to which the proposed plan will contribute to sound growth and development is dependent to a large degree on planning, zoning, and the provision of other public services in the project area.

CHAPTER 2

INTRODUCTION

BACKGROUND AND HISTORY

In May, 1970, a Missouri Water Pollution Board (now called the Missouri Clean Water Commission) hearing resulted in the placement of a construction ban on the watershed areas of the severely polluted Grand Glaize and Fishpot Creeks. In December of that year, the U.S. Environmental Protection Agency (EPA) awarded a Water Quality Assistance Management Grant to the East-West Gateway Coordinating Council to study these and other water pollution problems in the area of St. Louis that was outside the jurisdiction of the St. Louis Metropolitan Sewer District (MSD). Results of the initial phase of this study were published in 1972 as "St. Louis County Water Pollution Control Study, Phase I" (001). Pursuant to this publication, the EPA designated the St. Louis MSD as the planning and implementation authority for development of a Facilities Plan (201 Study Plan) for a sewerage system for the Lower Meramec River Basin. The context of the 201 study is described in the following paragraph.

Water Quality Management Basin Plan (303e Plan) for the Lower Meramec Basin was prepared by the Missouri Department of Natural Resources. The principal purpose of this Plan is to coordinate efforts to control water pollution in the Basin as a whole. The Plan identifies water quality problems, sets forth remedial programs, and identifies area-wide (208 Planning) and facility planning (201 Planning) needs and priorities. The Lower Meramec is given first priority ranking for 201 Planning (002). The 303 Plan designates Jefferson, St. Louis, and Franklin Counties and the City of St. Louis as a single wastewater management area. The waste treatment management study (208 Plan) for this area addresses problems of pollution control specific to the designated geographic region and further defines facility planning needs and priorities. The 208 Plan which includes the Lower Meramce was prepared by the East-West Gateway Coordinating Council. This plan also ranks the Lower Meramec as top priority for 201 Planning.

The 201 Plan which is the subject of this Environmental Impact Statement (EIS) covers the planning and preliminary design stages of the facilities study. It will culminate in a report containing a technical, economic, and environmental evaluation of alternate methods of meeting the requirements of the Federal Water Pollution Control Act Amendment.

PROBLEM DESCRIPTION

The Lower Meramec River (from the City of Times Beach to the Mississippi) has the most severe water quality problems in the basin (002) The Lower Meramec is used extensively for recreation and is classified by the Missouri Clean Water Commission as a "whole body contact" stream. It also serves as a source of raw water for systems serving 200,000 people (001). The stream and many of its tributaries, however, are subject to periodic high levels of pollutants during low-flow periods. In addition to fluctuations in flow, the principal factors adversely affecting the Lower Meramec's water quality may be summarized as follows (001, 002):

1. The River receives effluent from municipal, industrial, and private facilities in addition to receiving a relatively large amount of urban runoff.

2. Sewerage systems in both the St. Louis and Jefferson County portions of the basin were constructed in a piecemeal and uncoordinated manner and have not kept pace (in terms of either magnitude or treatment technology) with the area's expanding needs.

3. Many of the collection systems suffer from excess infiltration/inflow with resulting lift-station bypass.

4. Several treatment systems are overloaded periodically.

5. Although there are seven municipal facilities and a large number of private facilities in the basin, many developed areas in the basin are not provided with sewage treatment services.

As a result of these factors as well as urban runoff and periodic low-flow, the Lower Meramec River (from Times Beach to the Mississippi) has been classified by the Missouri Division of Environmental Quality as a "water quality limiting stream segment" (002). This classification is applied to a segment in which water quality does not meet applicable standards and is not expected to reach those standards even if secondary treatment for all point source discharges were applied.

ENVIRONMENTAL GOALS AND CONSTRAINTS

The ultimate goal of the 201 Plan is to upgrade the quality of the Lower Meramec's waters to acceptable standards. The immediate project goal, which is expected to help achieve these standards, is to provide a system of sewage collection and treatment which will be:

1. Cost effective
2. Under the control of a defined responsible agency
3. Not subject to the existing conditions of excess infiltration/inflow and resulting lift station bypass
4. Adequately sized to provide for present and projected treatment needs, and
5. Capable, in terms of organization, magnitude, and treatment technology, of offering uniform services to all users in accordance with federal and state standards

The major environmental constraints on the development of a regional wastewater system in the Lower Meramec are:

1. The status of the Lower Meramec River as a water quality-limited stream segment, which limits its use for receiving effluent
2. The "losing stream" character of several tributaries, which implies significant low-flow period, limiting their abilities to assimilate pollutants
3. The present and projected heavy use of the Lower Meramec for recreation
4. The existence of valuable scenic, ecological, and archaeological resources in the Lower Meramec Valley
5. The wide variation in engineering characteristics of the basin's substrates, including areas of Karst topography
6. The heavy concentration of urban development (both existing and projected) in the watershed areas of several Lower Meramec tributaries.

NECESSITY, PURPOSE, AND METHODOLOGY OF ENVIRONMENTAL IMPACT STATEMENT

The National Environmental Policy Act of 1969 (NEPA) requires all federal agencies to "utilize a systematic interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment." Section 102 (2) (c) of that act also requires the agency to prepare an Environmental Impact Statement (EIS) on, "major federal actions significantly affecting the quality of the human environment".

One of the major EPA programs involving actions which are candidates for EIS's is the construction grants program as authorized by Title 2 - "Grants for Construction of Treatment Works", Section 201 (g) (1), of the Federal Water Pollution Control Act Amendments of 1972 (EWPCA) (Public Law 92-500). The Act authorizes the administrator of EPA "to make grants to any state, municipality or intermunicipal or interstate agency for the construction of publicly owned treatment works". One stipulation of the grant may be the preparation of an EIS. This will be required if the appropriate regional office determines the project has "significant environmental effects".

The EIS is necessary because:

1. The project involves the possible use of the water-quality-limited Lower Meramec River as a receiving stream.

2. The study area includes valuable ecologic, scenic, recreational, and cultural resources.

3. Alternative plans examined during the course of project studies may have significant impacts on the area's environment.

4. "Secondary impacts" may result in controversies. Such impacts could include development induced by implementation of the project and the effects upon private sewer companies operating in the area.

To expedite development of the Facilities Plan, the EPA and MSD agreed to participate in a joint EIS; i.e. preparation of an EIS concurrently with other 201 Planning tasks. This arrangement also aids in the planning process by providing environmental-oriented input throughout the development of the plan. The EIS is being issued in compliance with the National Environmental

Policy Act of 1969. It has been prepared in accordance with Council on Environmental Quality (CEQ) guidelines dated August 1, 1973, EPA regulations dated April 15, 1975, and EPA's Manual for Preparation of Environmental Impact Statements for Wastewater Treatment Works, Facilities Plans, and 208 Areawide Waste Treatment Management Plans dated July, 1974.

The purposes of this EIS are to insure that:

1. All viable project alternatives are analyzed in light of their possible primary and secondary effects
2. The Lower Meramec's relative capacity to receive additional effluent and the treatment levels required for each alternate plan are analyzed; the impacts of year-round discharge on water quality, especially as they affect wildlife, recreation and drinking water supply would also be analyzed
3. The area's geologic characteristics, especially as they relate to the possibility of excess infiltration and groundwater pollution, are adequately considered and
4. Coordination with all concerned governmental agencies is carried out and public involvement elicited.

PUBLIC PARTICIPATION

It is the intent of the EIS guidelines cited above to encourage public participation, beginning at an early stage, in the EIS process. With this in mind, the following three-phase public participation program was developed for the Lower Meramec project:

Phase I, initiated at the beginning of the project, was designed to present the public with background information on the Facilities Plan and EIS studies and their purposes, and to solicit public opinions on environmental concerns. Two public workshops were held, one in Arnold, and one in Ellisville (lower and upper ends of the project area, respectively). Letters of inquiry were mailed to selected conservation groups and a public questionnaire with background material was prepared and distributed.

Phase II was designed to present and publicly discuss project alternatives and significant impacts associated with implementation of those alternatives. A public workshop for this Phase was held in Fenton, which is centrally located in the project area.

Phase III consisted of a public hearing on the draft EIS. The procedure and conduct of this public hearing is set forth in the Council on Environmental Quality Guidelines for the preparation of EIS's. In addition to the hearing, the draft EIS was made available for review and comment by interested organizations and the public.

Agency and public participation in the development of this EIS is in Chapter 7 of this statement. Chapter 7 presents in great detail substantial comments received, discussion of issues raised and changes in the project or the EIS which resulted from the comments.

AGENCIES INVOLVED

The principal agencies and organizations involved in the development of the 201 Facilities Plan and their major project-related functions are as follows:

1. Metropolitan St. Louis Sewer District (MSD) - acts as applicant for development of 201 Plan; assumes overall coordination responsibility; selects individual consultants and administers their contracts; coordinates development of study plans.

2. U. S. Environmental Protection Agency, Region VII - functions as chief regulatory agency for wastewater grant program; receives, reviews, and approves 201 work items; monitors activities of EIS consultant; directs and participates in preparation of EIS; acts in advisory capacity for all EIS phases.

3. Missouri Department of Natural Resources, Division of Environmental Quality - assumes responsibility for preparation of Water Quality Management Basin Plan (303 Plan); sets water quality standards in coordination with the EPA; issuing agency for NPDES permits.

4. East-West Gateway Coordinating Council - assumes responsibility for preparation of Areawide Waste Treatment Management Plan (208 plan); acts as A-95 clearinghouse and review agency for the St. Louis Standard Metropolitan Statistical Area.

5. Step I Consultants:

    a. EIS - Ryckman, Edgerley, Tomlinson & Associates

    b. Sewage Treatment - Consoer Townsend & Associates

c. Main Trunk System - Horner & Shifrin, Inc.

d. Kiefer Creek - Reitz & Jens, Inc.

e. Fishpot Creek - Havens & Emerson, Ltd.

f. Grand Glaize Creek - R. W. Booker & Associates, Inc.

g. Meramec Sub-5 - Lapin, Ellis, Dabler, Inc.

h. Meramec Sub-3,4,6 - Russel & Axon, Inc.

i. Fenton and Yarnell Creeks - Ernest Brown & Associates, Inc.

j. Meramec Sub-7 - Stolwyck, McDaniel, Ferrenbach, Inc.

k. Mattese Creek - Warren & Van Praag, Inc.

l. Meramec Sub-8 - Clark, Dietz & Associates, Inc.

CHAPTER 3

ENVIRONMENTAL SETTING

INTRODUCTION

The Lower Meramec River Basin occupies 140 square miles of eastern Missouri and represents approximately 4 percent of the Meramec River drainage system, which is tributary to the Mississippi River. The study area lies immediately to the south of the St. Louis metropolitan region and is greatly influenced by the growth and economic development of this expanding urban area.

The study area (Figures 1 and 2) includes twelve major watersheds and seven subwatersheds tributary to the Lower Meramec River. About 26 percent of the land area is developed, with about 23 percent in residential use. The vacant land, which is dominated by native forest cover, constitutes approximately 65 percent of the total land area. Projections for the study area include continued land use changes as urban areas expand to accommodate anticipated growth.

The lower Meramec River, with its timbered setting, caves, and scenic shoreline, has the potential of serving the surrounding area as a recreational resource. However, public facilities within the study area are extremely limited (059). Private vacation homes are dispersed along the shoreline in the more accessible areas from Valley Park to the mouth of the river.

The river serves as a potable water source for southern St. Louis County and receives municipal and industrial wastewater from 40 major discharges and many more minor discharges. The Meramec is a water quality limited stream from Times Beach to its confluence with the Mississippi. There currently are a number of planning studies aimed at coordinating efforts for water and wastewater management within the basin.

The air quality of the study area is affected by the urban/ industrial development within the basin. The St. Louis Air Quality Control Region, which includes the entire study area, is an Air Quality Maintenance Area for a number of pollutants. (e.g., levels of pollutants exceed national standards, see Glossary). Plans are being developed to control emissions and reduce air pollution problems.

The following sections of Chapter 3 describe in detail the existing environment of the Lower Meramec Basin. The sections focus on elements of the environment which would affect or be

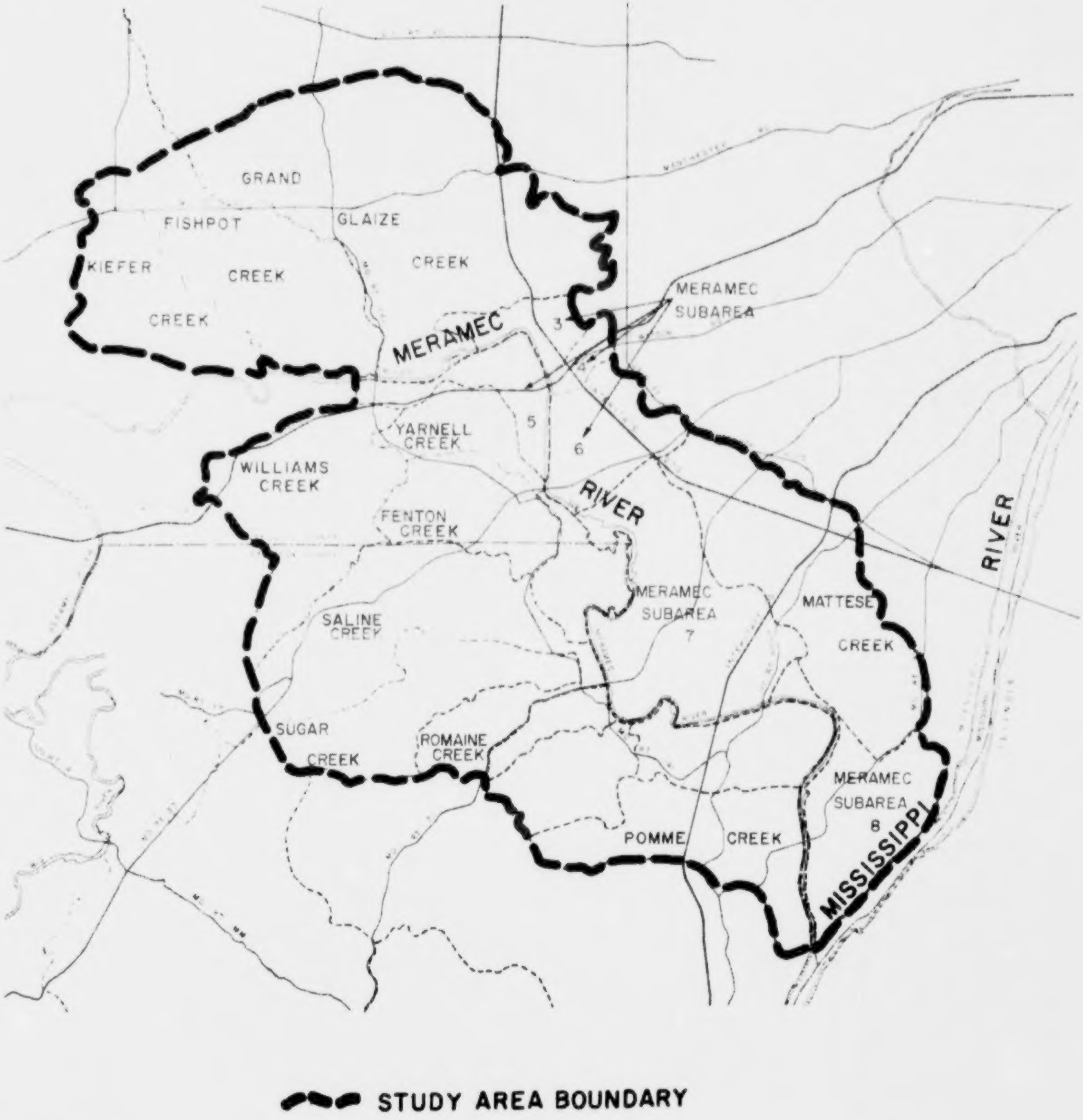

GRAND
FISHPOT
GLAIZE
CREEK
KIEFER
CREEK
CREEK
MERAMEC
MERAMEC
SUBAREA
3
4
5
6
YARNELL
CREEK
WILLIAMS
CREEK
RIVER
FENTON
CREEK
RIVER
MERAMEC
SUBAREA
7
MATTESE
CREEK
SALINE
CREEK
SUGAR
CREEK
ROMAINE
CREEK
MERAMEC
SUBAREA
8
POMME
CREEK
MISSISSIPPI
STUDY AREA BOUNDARY

FIGURE 1
STUDY AREA

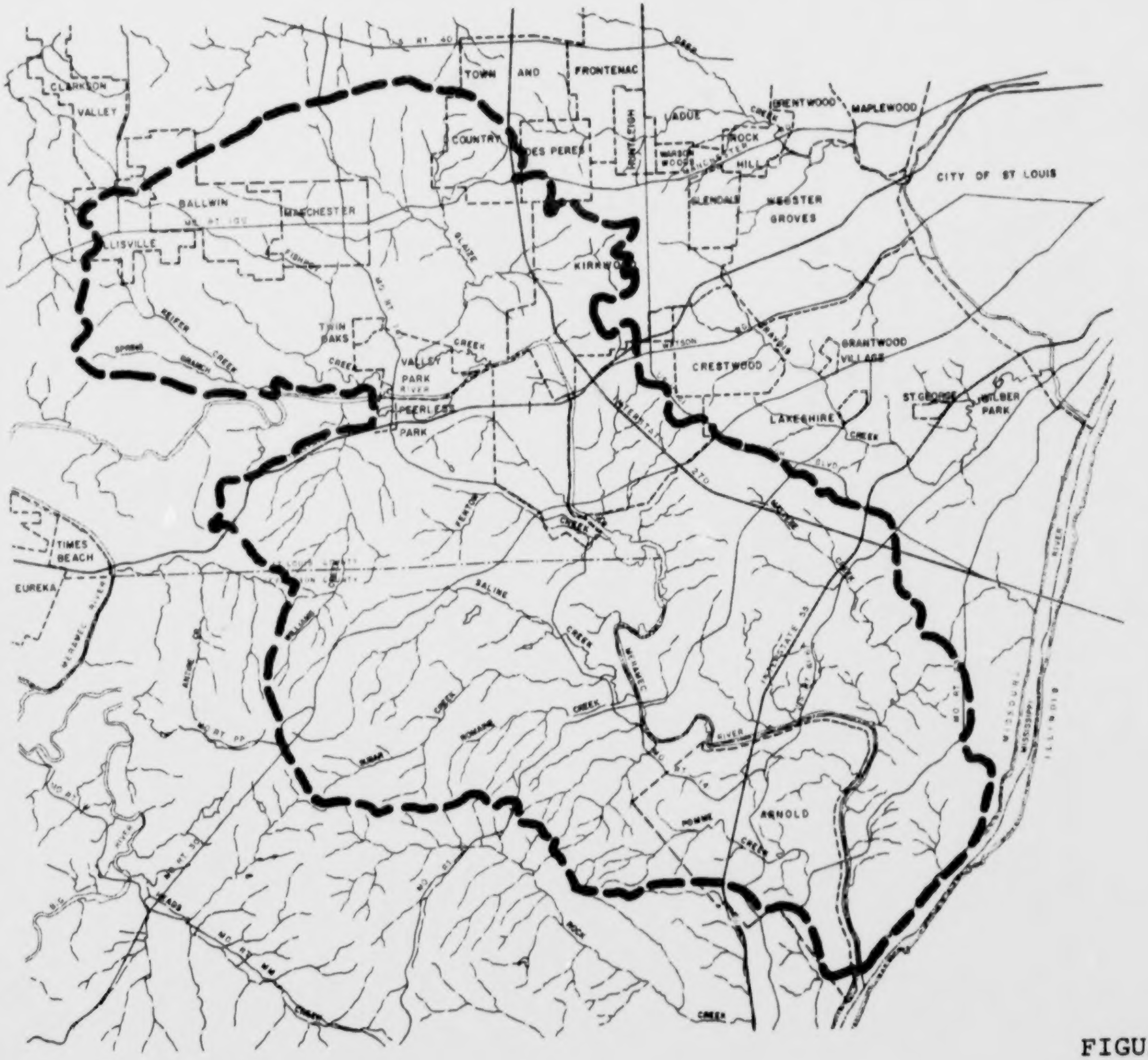

CLARKSON
VALLEY
BALLWIN
MANCHESTER
ELLISVILLE
TOWN AND COUNTRY
FRONTENAC
DES PERES
HUNTLEIGH
LADUE
BRENTWOOD
MAPLEWOOD
ROCK HILL
WARSON WOODS
GLENDALE
WEBSTER GROVES
CITY OF ST LOUIS
KIRKWOOD
TWIN OAKS
VALLEY PARK
PEERLESS PARK
CRESTWOOD
GRANTWOOD VILLAGE
LAKESHIRE
ST GEORGE
WILBER PARK
TIMES BEACH
EUREKA
ARNOLD
MERAMEC RIVER
SALINE CREEK
FENTON CREEK
GRAVOIS CREEK
FISHPOT
KEIFER CREEK
GRAND GLAIZE
ROCK CREEK
MISSOURI
MISSISSIPPI RIVER
ILLINOIS
INTERSTATE 270
INTERSTATE 55
US RT 40
MO RT 100
MO RT PP
MO RT 21
MO RT 30
MO RT MM

FIGURE 2
LOCATION MAP

affected by development of the proposed sewerage and wastewater treatment facilities and include the anticipated secondary effects of such development.

LOCATION

The Lower Meramec River Basin study area (see Figure 1) includes portions of central and southeastern St. Louis County and northeastern Jefferson County. The St. Louis County portion of the study area consists of six major watersheds (Kiefer, Fishpot, Grand Glaize, Yarnell, Fenton, and Mattese Creeks) and six subwatersheds of the Meramec (designated 3, 4, 5, 6, 7, and 8). The Jefferson County portion of the study area consists of six major watersheds tributary to the Lower Meramec River (Saline, Sugar, Romaine, Little Muddy, Muddy, and Pomme Creeks). The Williams Creek Watershed is included in the study area and is located in both St. Louis and Jefferson Counties. Municipalities located within the study area are listed in Table 1.

TABLE 1

MUNICIPALITIES INCLUDED IN THE
LOWER MERAMEC RIVER BASIN STUDY AREA

Arnold
Ballwin
Des Peres (only a small portion)
Ellisville
Fenton
Kirkwood
Manchester
Peerless Park
Sunset Hills
Town and Country
Twin Oaks
Valley Park
Winchester

CLIMATE

Since climate can significantly affect surface stream flow rates, air quality susceptibility to air pollution episodes, transportation planning, and an area's development suitability, climatological factors must be considered when planning wastewater treatment facilities that might induce population growth.

St. Louis is located near the geographic center of the United States and has a modified continental climate. To the south is the warm moist air of the Gulf of Mexico. To the north, in Canada, is a favored region for cold air masses. The alternate invasion of air masses from these sources and the conflict along frontal zones where they come together produces varied weather conditions (004).

Lambert Airport in St. Louis County is located approximately nine miles to the north of the study area, and weather records for that location are representative of the study area as a whole. These records, however, are concerned with mesoscale phenomena (i.e., a spatial scale of 10 to 100 miles and a time frame in hours to days) and are not indicative of localized variations. They do take into account large-scale influences such as the "urban heat island" effect, valley winds, and atmospheric stability. Meteorological conditions, on a microscale (a few feet to several thousand feet horizontally, with a time frame of minutes to hours) are subject to considerable variation from broader-scale conditions. Data on conditions at this scale are not routinely collected for all areas, of course, since the cost of such a program would be prohibitive. However, it is possible, on the basis of established phenomena, to predict the general types of microscale variations which will occur in the study area. Chief among these are variations related to the area's rough topography and river-valley location. The area's valley location results in increased diurnal fluctuations in wind speed and direction due to differential conductivity, as well as localized variations in humidity. Rougher terrain is generally associated with greater atmospheric turbulence. A combination of the two aforementioned characteristics often results in localized variation in precipitation patterns. Monthly and annual climatic statistics are summarized in Table 2.

Precipitation in the study area averages 35.89 inches per year (in/hr), but has varied between 20.59 inches in 1953 and 68.83 inches in 1958. The average annual evapotranspiration for the Meramec River Basin is approximately 25 inches, leaving a potential water surplus of approximately 11 inches (117). The spring and early summer months (April through July) are usually the wettest. Intense rainfall events (0.25 inches or more in 1 hour) occur approximately 25 times per year and are most likely to occur in June or July (029). In the winter, snowfalls of 1 inch or greater occur an average of six times (004).

Temperatures in St. Louis have ranged from 106°F in July, 1966 to -11°F in January, 1963 (004). Extended periods of hot humid weather occur most summers, when a steady flow of air from the Gulf of Mexico dominates the atmospheric circulation. In the winter, polar air originating from the north causes temperatures to remain below the freezing mark in the greater St. Louis area for about 20 days per year and to dip below 0°F on two or three occasions per year (004). The average date of the last freeze in the spring is April 15; the average date of the first frost in the fall is October 20 (006).

The frequency of cloud cover at St. Louis varies with the seasons. Summers are sunny, with July receiving about 70 percent

TABLE 2

NORMALS, MEANS AND EXTREMES(a) (b)

(Recorded at Lamber-St. Louis International Airport)
1958-1974

	Temperatures °F					Normal Degree Days Base 65°F		Precipitation in inches						
	Normal	Extremes												
Month(c)	Monthly	Record Highest	Year	Record Lowest	Year	Heating	Cooling	Normal	Maximum Monthly	Year	Minimum Monthly	Year	Maximum in 24 hrs.	Year
J	31.3	76	1970	-11	1963	1,045	0	1.85	3.61	1969	0.22	1970	2.16	1967
F	35.1	85	1972	-2	1965	837	0	2.06	4.17	1974	0.25	1963	2.56	1959
M	43.3	88	1963	3	1974	682	9	3.03	5.81	1973	1.09	1966	1.84	1962
A	56.5	92	1970	22	1972	272	17	3.92	9.09	1970	1.37	1959	2.33	1970
M	65.8	92	1972	31	1966	103	128	3.86	7.25	1961	1.02	1972	2.94	1974
J	74.9	98	1971	43	1969	10	307	4.42	8.65	1969	0.47	1959	3.29	1960
J	78.6	106	1966	51	1972	0	422	3.69	7.81	1958	0.60	1970	3.16	1958
A	77.2	105	1962	47	1965	0	378	2.87	6.44	1970	0.08	1971	2.66	1974
S	69.6	100	1971	36	1974	35	173	2.89	6.21	1972	0.76	1960	2.85	1969
O	59.1	94	1963	25	1972	224	41	2.79	5.77	1969	0.46	1965	2.14	1969
N	45.0	81	1971	1	1964	600	0	2.47	5.74	1968	0.44	1969	2.87	1972
D	34.6	76	1970	-6	1973	942	0	2.04	6.50	1971	0.32	1958	2.57	1971
YR	55.9	106	Jul 1966	-11	Jan 1963	4,750	1,475	35.89	9.09	Apr 1970	0.08	Aug 1971	3.29	Jun 1960

TABLE 2

NORMALS, MEANS, AND EXTREMES[(a)] [(b)]
(Recorded at Lambert-St. Louis International Airport)
1958-1974
(Continued)

	% Relative Humidity				Wind							Mean Numbers of Days							Temperatures °F			
							Fastest Mile					Sunrise to Sunset							Max.		Min.	
	Hour 00 (Local Time)	Hour 06	Hour 12	Hour 18	Mean Speed (mph)	Prevailing Wind Direction	Speed (mph)	Direction	Year	% of Possible Sunshine	Mean Sky Cover, Tenths, Sunrise to Sunset	Clear	Partly Cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice Pellets 1.0 inch or more	Thunderstorms	Heavy Fog, Visibility 1/4 mile or less	90° and above[(d)]	32° and below	32° and below	0° and below
J	76	81	64	68	10.2	NW	39	W	1970	52	6.8	7	7	17	8	2	1	2	0	11	27	2
F	75	79	60	63	10.8	NW	46	NW	1967	52	6.5	7	6	15	8	1	1	1	0	6	23	*
M	73	80	57	58	11.7	WNW	45	NE	1968	54	6.8	6	9	16	11	1	3	1	0	1	15	0
A	70	77	54	53	11.4	WNW	45	W	1964	56	6.6	7	8	15	12	*	6	1	*	0		0
M	75	82	56	55	9.5	S	42	SE	1970	61	6.2	8	9	14	10	0	6	*	1	0	*	0
J	78	84	57	56	8.6	S	60	SE	1964	69	5.9	8	11	11	9	0	7	*	8	0	0	0
J	78	86	57	56	7.7	S	40	NW	1969	70	5.6	9	12	10	9	0	7	*	13	0	0	0
A	80	89	57	58	7.4	S	48	NW	1966	66	5.4	10	12	9	7	0	6	*	11	0	0	0
S	83	91	60	63	8.0	S	39	SW	1974	63	5.1	12	7	11	9	0	4	1	4	0	0	0
O	76	84	55	60	8.5	S	48	SW	1967	61	4.9	13	8	10	8	0	2	1	*	0	2	0
N	78	84	62	68	9.9	S	41	S	1961	49	6.1	9	7	14	8	1	1	1	0	1	13	0
D	81	85	69	74	10.2	WNW	44	W	1968	42	6.9	7	6	18	10	1	1	2	0	7	24	1
YR	77	83	59	61	9.5	S	60	SE	Jun 1964	58	6.1	103	102	160	109	6	44	11	37	26	106	3

NOTES: [(a)] Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 115 in July 1954; lowest temperature -23 in January 1864; maximum monthly precipitation 20.45 in August 1946; minimum monthly precipitation 0.00 in November 1865; maximum precipitation in 24 hours 8.78 in August 1946; maximum monthly snowfall 28.8 in March 1912; maximum snowfall in 24 hours 20.4 in March 1890; fastest mile of wind 91 from Northwest in May 1896.

Normals - Based on record for the 1941-1970 period
Date of an Extreme - The most recent in cases of multiple occurrence
Prevailing Wind Direction - Record through 1963
Wind Direction - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm
Fastest Mile Wind - Speed is fastest observed 1-minute value when the direction is in tens of degrees

[(b)] * = Less than one half
T = Trace

[(c)] Length of record, years, through the current year unless otherwise noted, based on January data

[(d)] 70° and above at Alaskan stations

Source: (004)

of the maximum possible sunshine. December is usually the most overcast month with an average of 42 percent of the maximum possible sunshine (004). Seventy-seven percent of the mean annual evaporation at St. Louis occurs from May to October (007).

As shown in Figures 3, 4 and 5, which depict average annual wind speeds and directions, the predominant wind direction is from the south occurring with a frequency greater than 10 percent. The greater St. Louis area is not particularly susceptible to heavy wind storms. Wind speed averages are highest in March and April and lightest during August.

In the period recorded from 1916 to 1965, 30 tornadoes were observed in St. Louis City and County and eight in Jefferson County. Although tornadoes can occur during any season, the probability for occurrence is greatest from March through June (008).

LAND RESOURCES

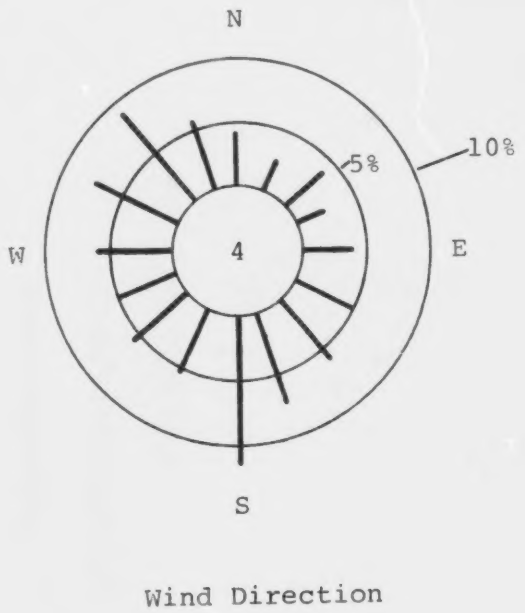
Geology

A basic understanding of the geologic structure of an area is essential background for the realistic evaluation of the area's potential for development. Such an understanding is important in predicting project life and cost effectiveness as well as in assuring that design standards and construction specifications are developed in a manner guaranteeing both project efficiency and environmental protection. The following section presents a geologic characterization of the project area in terms of stratigraphic relationships, lithologic and hydrologic characteristics, and engineering properties. This information is provided as a basis for project decision-making.

Stratigraphy

The study area's geology can be divided into two broad categories: bedrock geology and recent geology.

Bedrock Geology - The stratigraphic sequence consists primarily of limestones and dolomites which were deposited, for the most part, in shallow epicontinental seas. The rocks range in age from Precambrian to Pennsylvanian (>600 million years ago to 280 million years ago). A composite stratigraphic section for the St. Louis area is shown in Table 3, and a generalized geologic map is shown in Figure 6. Some of the upper Pennsylvanian System rocks are not found within the study area, but



RETA
R806

FIGURE 3

ANNUAL WIND DIRECTION
FREQUENCY DISTRIBUTION

Source: (001)

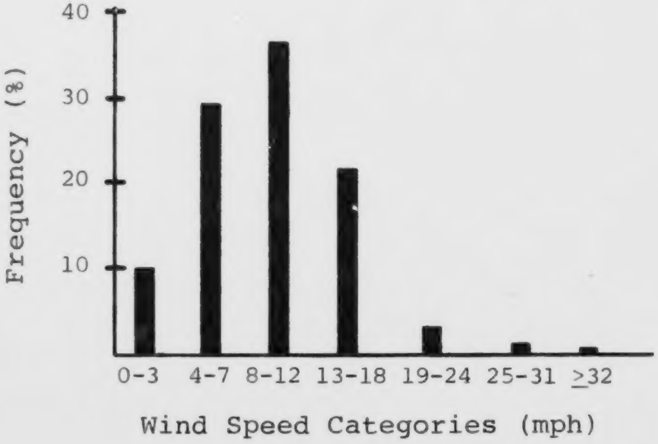


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FIGURE 4

ANNUAL WIND SPEED
FREQUENCY DISTRIBUTION

Source: (001)

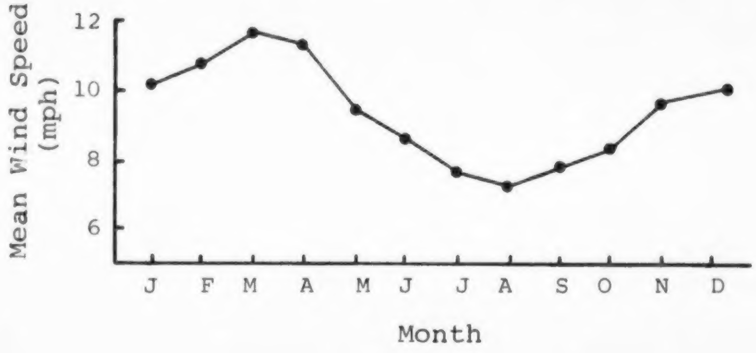

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FIGURE 5

MONTHLY MEAN WIND SPEEDS

Source: (001)

TABLE 3

GENERALIZED STRATIGRAPHIC COLUMN FOR ST. LOUIS AND JEFFERSON COUNTIES, MO (a)(b)

Millions of Years Before Present	System	Series	Group	Formation	Aquifer Group	Thickness (feet)	Dominant Lithology	Water-bearing Character
	Quaternary	Holocene		Alluvium (c)(d)		0-150	Sand, gravel, silt & clay	Some wells yield more than 2,000 gpm
0.01		Pleistocene		Loess		0-110	Silt	Essentially not water yielding
				Glacial till		0-55	Pebbly clay & silt	
2	Not Represented							
280	Pennsylvanian	Missourian	Pleasanton	Undifferentiated		0-75	Shales, silt-stones, "dirty" sandstones, coal beds & thin limestone beds	Generally yields very small quantities of water to wells. Yields range from 0-10 gpm
		Desmoinesian	Marmaton	Undifferentiated		0-90		
			Cherokee	Undifferentiated		0-200		
		Atokan		Undifferentiated				
	Mississippian	Meramecian		Ste. Genevieve		0-160	Argillaceous to arenaceous limestone	Yields small to moderate quantities of water to wells. Yields range from 5 to 50 gpm. Higher yields are reported for this interval locally.
				St. Louis Limestone		0-180		
				Salem		0-180		
				Warsaw		0-110		
		Osagean		Burlington-Keokuk Limestone	1	0-240	Cherty limestone	
				Fern Glen		0-105	Red limestone & shale	
		Kinderhookian	Chouteau	Undifferentiated		0-122	Limestone, dolomitic limestone, shale, & siltstone	
395	Devonian	Upper	Sulphur Springs	Bushberg Sandstone		0-60	Limestone & sandstone	
				Glen Park Limestone				
				Grassy Creek Shale		0-50	Fissile, carbonaceous shale	
	Silurian			Undifferentiated		0-200	Cherty limestone	
435	Ordovician	Cincinnatian		Maquoketa Shale		0-163	Silty, calcareous or dolomitic shale	Probably constitutes a confining influence on water movement
				Cape Limestone		0-5	Argillaceous limestone	Yields small to moderate quantities of water to wells. Yields range from 3 to 50 gpm. Decorah Formation probably acts as a confining bed locally.
		Champlainian		Kimmswick	2	0-145	Massive limestone	
				Decorah		0-50	Shale with interbedded limestone	
				Plattin		0-240	Finely crystalline limestone	
				Rock Levee		0-93	Dolomite & limestone, some shale	
				Joachim Dolomite		0-135	Primarily argillaceous dolomite	
				St. Peter Sandstone (d)	3	0-160	Silty sandstone, cherty limestone grading upward into quartzose sandstone	Yields moderate quantities of water to wells. Yields range from 10-140 gpm.
				Everton		0-130		

TABLE 3

GENERALIZED STRATIGRAPHIC COLUMNS FOR ST. LOUIS AND JEFFERSON COUNTIES, MO[a][b]

(continued)

Millions of Years Before Present	System	Series	Group	Formation	Aquifer Group	Thickness (feet)	Dominant Lithology	Water-bearing Character
	Ordovician (continued)	Canadian		Powell Dolomite	4	0-150	Sandy & cherty dolomites & sandstone	Yields small to large quantities of water to wells. Yields range from 10 to 300 gpm. Upper part of aquifer group yields only small amounts of water to wells.
				Cotter Dolomite		0-320		
				Jefferson City Dolomite		0-225		
				Roubidoux[d]		0-177		
				Gasconade Dolomite Gunter Sandstone Member[d]		0-280		
500	Cambrian	Upper		Eminence Dolomite	5	0-172	Cherty dolomites, siltstones, sandstone, & shale	Yields moderate to large quantities of water to wells. Yields range from 10 to 400 gpm.
				Potosi Dolomite[d]		0-325		
			Elvins	Derby-Doerun Dolomite		0-165		
				Davis		0-150		
				Bonneterre		245-385		
				Lamotte Sandstone		235+		
600	Precambrian						Igneous & metamorphic rocks	Does not yield water to wells in this area.

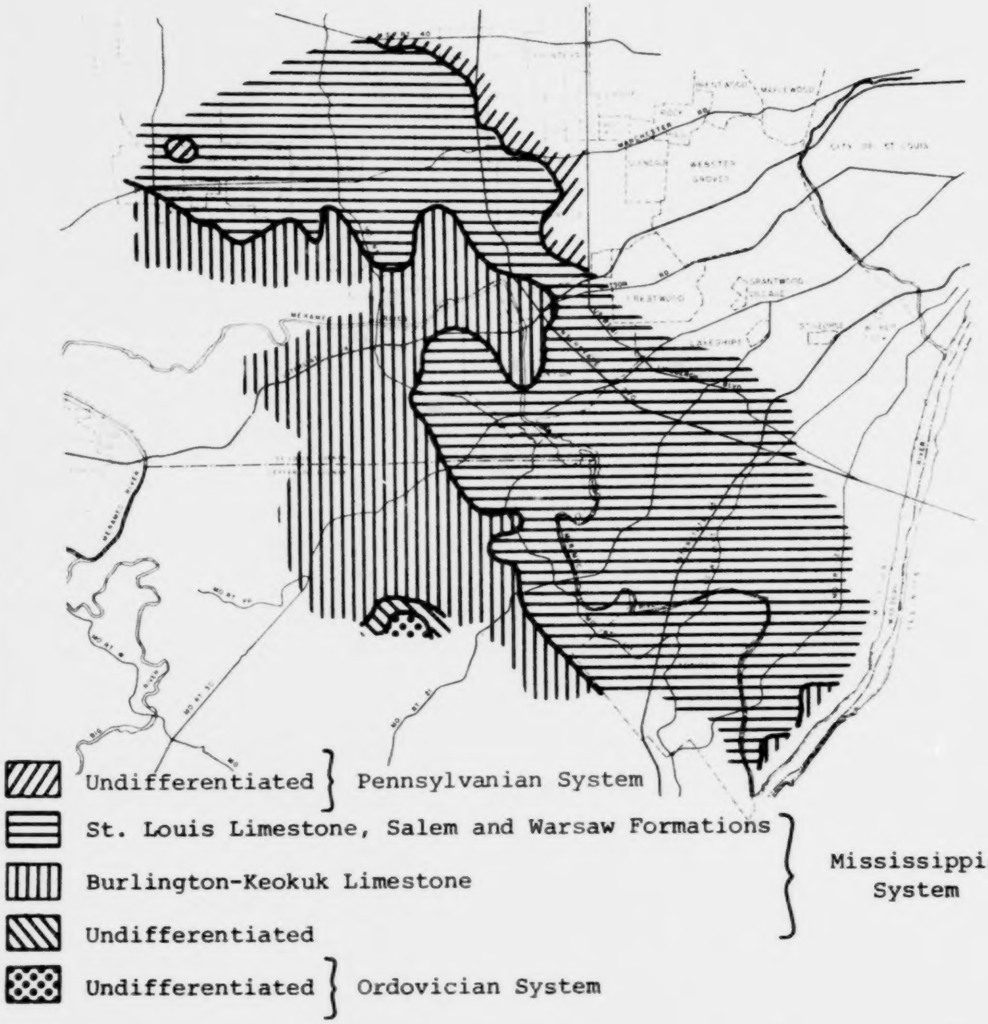
NOTES: [a] Stratigraphic nomenclature may not necessarily be that of the U. S. Geological Survey.

[b] ---- = unconformity.

[c] Basal part may be of Pleistocene age.

[d] Aquifers most favorable as water sources.

Source: (009)


MAPLEWOOD
MANCHESTER RD
CITY OF ST LOUIS
WEBSTER GROVES
CRESTWOOD
GRANTWOOD VILLAGE
LAKESHIRE
ST GEORGE
MERAMEC RIVER
▨ Undifferentiated } Pennsylvanian System
▤ St. Louis Limestone, Salem and Warsaw Formations
▥ Burlington-Keokuk Limestone
▧ Undifferentiated
} Mississippian System
░ Undifferentiated } Ordovician System

RETA

FIGURE 6

GENERALIZED GEOLOGIC MAP

Source: (010)

crop out just to its north. As indicated in Table 3, all of the formations are of variable thickness mainly due to many periods of emergence and subsequent erosion. Bedrock older than the Mississippian System does not crop out in the study area (009). Little is known about the Cambrian and Precambrian System rocks underlying the study area because more recent bedrock overlying them is very thick.

Rocks in the Ordovician System crop out extensively in western St. Louis County and just south of the study area in Jefferson County. The most notable of these is the St. Peter Sandstone which crops out in west St. Louis County, where it is used as a source of pure silica sand. The St. Peter Sandstone is porous and permeable and is an important source of groundwater.

The formation which generally overlies the St. Peter Sandstone formation is the Joachim Dolomite formation. This extensive thin-bedded unit is a predominantly yellowish brown, clayey dolomite with interbedded limestone and shale in some portions. The rest of the formations representing the Ordovician System are dense, massively bedded limestones, containing varying amounts of chert. They are moderate-solution limestones and some isolated sinkholes have developed in them. Small caves and springs near the outcrop belt indicate that these formations are cavernous, although no large caves have been found in the study area.

The Mississippian is the most extensively represented system in the study area. A prominent formation throughout the Hilly Uplands topographic region is the Burlington-Keokuk Limestone, which is classified as a member of the Mississippian System. This is a very cherty, coarsely crystalline, soluble limestone, with light grey to cream colored beds. It is medium to heavy bedded, well jointed, and permeable as a whole. The chert frequently occurs as beds, and often forms protruding ledges. Where exposed, the bedrock surface sometimes forms cutters and pinnacles. Scattered sinkholes and caves have developed in the outcrop area.

Overlying the Burlington-Keokuk Limestone is the Warsaw formation (see Table 3) which is predominantly a soft, fossiliferous shale, containing some grey thin-bedded limestone near the base of the formation.

The next unit upwards in the local stratigraphy of the Mississippian System is the Salem formation. In the lower portion, it is typically composed of a thin-bedded sequence of shale, siltstone, and limestone. The upper portion is very similar to the overlying St. Louis limestone.

The upper part of the Salem Limestone and the St. Louis Limestone formations underlie a large portion of the study area. They are pure, dense, massively bedded grey to light grey limestones, with a maximum thickness of over 300 feet. They have undergone extensive weathering and are extremely cavernous. Under the weight of soil overburden, portions of the ceilings of many of the near surface caverns have collapsed, forming sinkholes. The presence of large numbers of sinkholes is a good indication that the underlying bedrock formation is the St. Louis Limestone. However, in many areas where the St. Louis Limestone is present, the thick soil cover effectively masks the presence of solutional features.

Rocks belonging to the Pennsylvanian System are also present in a few areas within the study area. These rocks are cyclic sequences of shales, sandstones, siltstones, and limestones, with occasional thin seams of coal and an accompanying underclay. These rocks are covered by a thick deposit of loess and do not crop out in the study area.

Recent Geology - There are three types of recent deposits in the study area: alluvium, residuum, and loess. Loess is an aeolian (wind-transported) deposited sediment consisting of predominantly silt-sized particles. Loess deposits in the study area were almost exclusively derived from glacial deposits to the north which were continuously reworked by proglacial streams as the glaciers advanced and retreated. This reworking of the glacial deposits meant that an abundance of fine-grained sediment was always exposed to the periglacial winds, which picked up the fine-grained particles and deposited them in a graded fashion on the upland areas to the south and east. Loess is highly erodible and much of the material that was deposited on steeper hillsides has washed down into the bottomland areas, resulting in thick primary deposits of loess on the relatively flat ridge tops, very thin or no loess on the steeper slopes, and localized, thick, colluvial deposits which are located along the bases of hills and are nearly indistinguishable from the loess they were derived from.

Recent alluvial (water-transported) deposits are found in valley bottoms and floodplains throughout the study area. The Mississippi River bottom is predominantly composed of sand with some fine gravel, although patches of siltier material are not uncommon.

The average elevation of the Mississippi River bottom in the St. Louis metropolitan area appears to be decreasing, based on the records of the low water reference plane (L.W.R.P.). The L.W.R.P. is established by the U.S. Army Corps of Engineers, and is the lowest stage at which they can guarantee a nine-foot deep navigation channel. At the St. Louis Gage, this corresponds to a discharge of 54,000 cubic feet per second (cfs). Since 1942, the L.W.R.P. has dropped 1.2 feet, and now corresponds to -3.2 feet at the St. Louis Gage. At the confluence of the Meramec and Mississippi River (River Mile 161.0), the Mississippi River L.W.R.P. has an elevation of 368.7 feet above mean sea level.[1]

The Meramec River alluvium has a maximum thickness of 80 feet (009, 011). The texture ranges from a silty clay to sand and gravel with a few boulders within the same 79-foot deep boring (009). This same variability is encountered laterally (see Figures 7 and 8). As shown in Figure 7, the major tributaries to the Meramec also contain an appreciable thickness of alluvium. In scattered locations throughout the study area, there are relatively flat areas of alluvium above the present floodplains. These are stream terrace deposits which were laid down while the glaciers were receding and the streams currently in existence were flowing at higher elevations. Most of the terrace deposits are relatively thin compared to the adjacent alluvium. However, some of the terrace deposits along the Meramec River are fairly thick (50 - 70 feet) (012).

Throughout, essentially, the entire study area, unconsolidated residual materials have formed in place on parent bedrock. The residuum is predominantly clay, but contains varying amounts of quartz sand and chert, depending on the character of the parent rock (013). The most extensive areas of exposed residum are in the southern part of the study area. Where the parent bedrock is cherty, (e.g., the Burlington-Keokuk formation), the residuum tends to be highly permeable. The residuum generally tends to have a high shrink/swell potential, and is only moderately erodible (011, 014).

Structure - The study area is on the northeast edge of the Ozark Uplift. Superimposed on all of the minor structures is a regional northeast dip of about 50 to 80 feet per mile (see Figure 9). The sedimentary rocks are relatively parallel at this angle, even though there are numerous periods of nondeposition, uplift, and erosion in the stratigraphic record (see Table 3).

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[1] Personal Communication, George Clapp, Geodetic Survey Section, U. S. Army Corps of Engineers, St. Louis District, March, 1977.

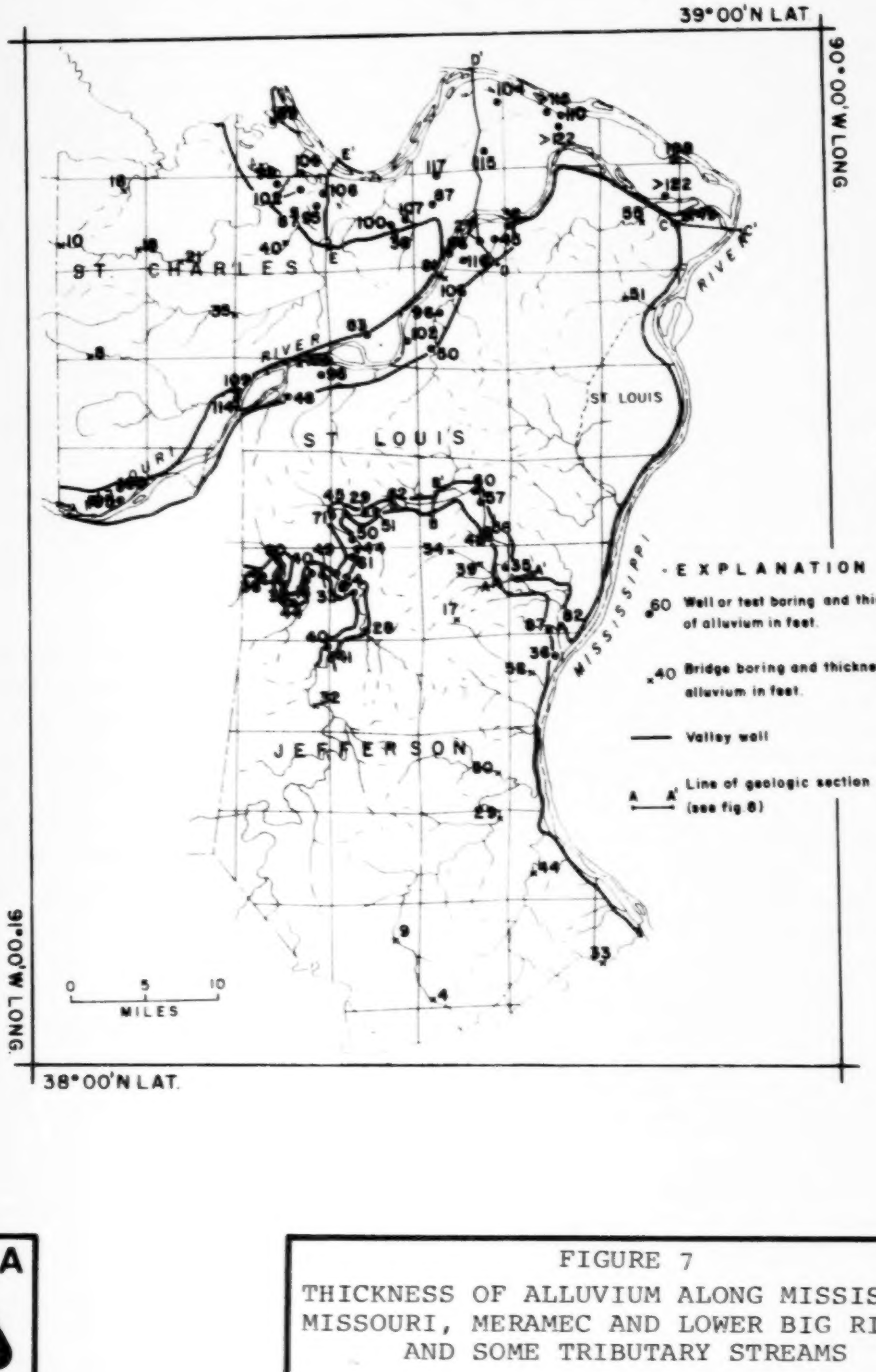
39°00'N LAT
90°00'W LONG
91°00'W LONG
38°00'N LAT
ST CHARLES
ST LOUIS
ST LOUIS
JEFFERSON
MISSISSIPPI
RIVER
MISSOURI
0 5 10
MILES
EXPLANATION
60 Well or test boring and thickness of alluvium in feet.
40 Bridge boring and thickness of alluvium in feet.
Valley wall
A A' Line of geologic section (see fig. 8)

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FIGURE 7
THICKNESS OF ALLUVIUM ALONG MISSISSIPPI, MISSOURI, MERAMEC AND LOWER BIG RIVERS, AND SOME TRIBUTARY STREAMS

Source: (009)

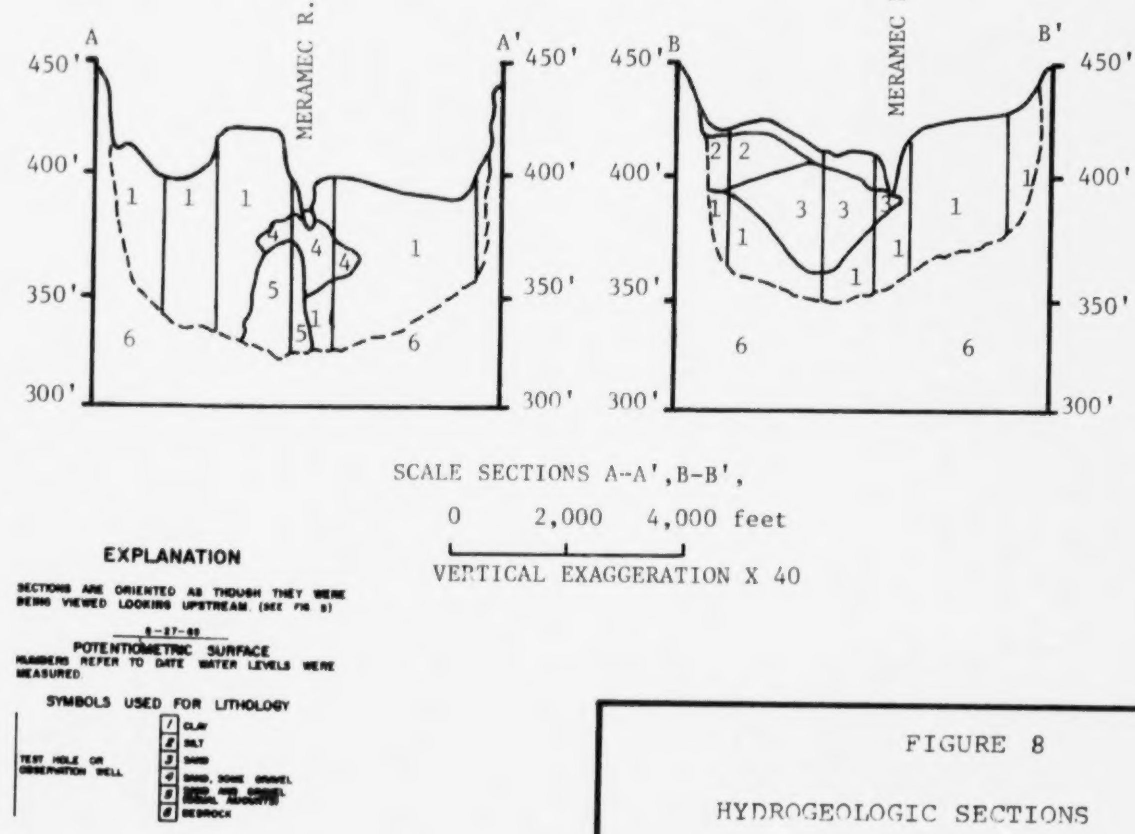
A
A'
B
B'
450'
400'
350'
300'
MERAMEC R.
1
2
3
4
5
6
SCALE SECTIONS A-A', B-B',
0
2,000
4,000 feet
VERTICAL EXAGGERATION X 40
EXPLANATION
SECTIONS ARE ORIENTED AS THOUGH THEY WERE BEING VIEWED LOOKING UPSTREAM. (SEE FIG 9)
8-27-80
POTENTIOMETRIC SURFACE
NUMBERS REFER TO DATE WATER LEVELS WERE MEASURED.
SYMBOLS USED FOR LITHOLOGY
TEST HOLE OR OBSERVATION WELL
1 CLAY
2 SILT
3 SAND
4 SAND, SOME GRAVEL
5 SAND AND GRAVEL, [illegible]
6 BEDROCK

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FIGURE 8

HYDROGEOLOGIC SECTIONS

As indicated in Figure 9, there are a few inferred faults in the general area of the project. There is, however, no significant seismicity (earth vibration) in the St. Louis area. The nearest center of seismic activity is approximately 200 miles from the study area near New Madrid, Missouri. Due to this lack of recent seismic activity, it is unlikely that earthquakes will affect the project during its life. Further, due to the great depth at which the New Madrid activity is occurring and the characteristics of the strata in which the project would be constructed little or no damage to the project would be caused by seismic activity which does occur (118). Although the study area has no major structural deformations, there is a minor syncline postulated in the Valley Park vicinity. The presence of minor structural deformations is often due to local solution of the underlying limestone and subsequent collapse of the overlying strata.

Geologic Engineering Considerations - The most pertinent geology-related engineering characteristics of the project study area are summarized in Table 4. Only those deposits/strata related to the proposed project are listed.

Topography

There are four main topographic regions in the study area: 1) the Hilly Uplands region; 2) the Rolling Uplands regions; 3) the Karst region; and 4) the Bottomland region (see Figure 10). The Hilly Uplands region is the most extensive. It includes most of the drainage basins of Kiefer and Fishpot Creeks, north of the Meramec River, and the area from Williams Creek east to the Pomme Creek drainage basin, south of the Meramec River. Local relief between ridges and valleys varies between 100 and 300 feet, and typically contains slopes in excess of 20 percent. The drainage divide between Saline Creek and Antire Creek (High Ridge) is the maximum elevation in the study area (940 feet).

The Rolling Uplands region extends from Grand Glaize Creek eastward to the Karst region on the north side of the Meramec River, and includes the Pomme Creek drainage basin to the south of the river. Largely because of the presence of a thick loess mantle, this region's topography is more subdued than that of the Hilly Uplands region. A typical ridge top or hilltop elevation in this region is 650 feet.

The Karst region is located in the easternmost portion of the study area (in the Mattese Creek's eastern drainage area), where the St. Louis Limestone formation is the surface bedrock unit. The Karst region is a partially dissected plateau containing numerous sinkholes, many of which occur in clusters, and some of

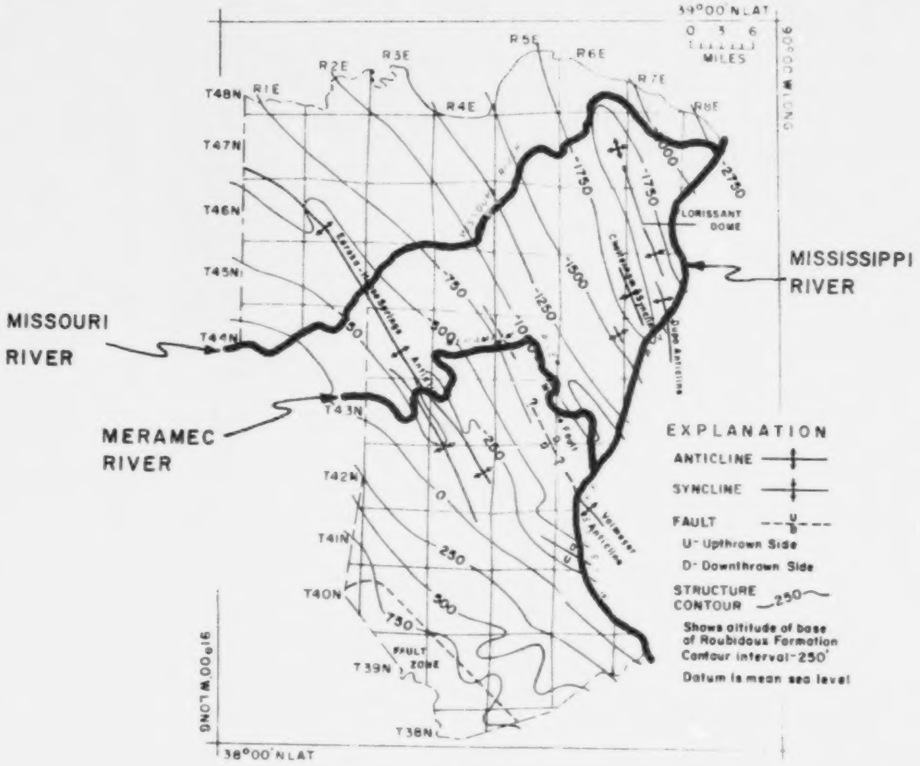
39°00'N LAT
0 3 6
MILES
90°00'W LONG
R1E
R2E
R3E
R4E
R5E
R6E
R7E
R8E
T48N
T47N
T46N
T45N
T44N
T43N
T42N
T41N
T40N
T39N
T38N
MISSOURI RIVER
MERAMEC RIVER
MISSISSIPPI RIVER
LORISSANT DOME
Dupo Anticline
Waterloo Anticline
FAULT ZONE
-750
-500
-1250
-1500
-1750
-2750
-250
0
250
500
750
91°00'W LONG
38°00'N LAT
EXPLANATION
ANTICLINE
SYNCLINE
FAULT
U
D
U- Upthrown Side
D- Downthrown Side
STRUCTURE CONTOUR
250
Shows altitude of base of Roubidoux Formation
Contour interval-250'
Datum is mean sea level

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FIGURE 9

MAJOR STRUCTURAL FEATURES

TABLE 4

GEOLOGIC ENGINEERING CONSIDERATIONS - LOWER MERAMEC VALLEY [(a)]

Deposit or Stratum	Engineering Considerations
Recent Alluvium	Texture ranges from silty clay to sandy silt; erratic and non-uniform in engineering properties; water-filled and high coefficient of permeability; low bearing strength; subject to flooding
Remnant Alluvium	Texture similar to recent alluvium, but with more predominant sand seams; engineering properties also similar, but even greater permeability; low bearing strength; subject to flooding
Sand and Gravel	Gravel content varies from 10 to 50% and silt/clay particles from 5 to 10% with clays more predominant toward the confluence with the Mississippi; high permeability; low bearing strength; subject to flooding
St. Louis Limestone	High lime/low chert content; interbedded with shales; Karst topography masked by thick soil cover
Burlington Limestone	Deep; hard, and cherty; sound and competent; low-yield aquifer, except in floodplain, where joints and fractures transmit water from alluvial overburden
Salem Formation	Limestone and shale interbedded, but generally competent and sound; low hydraulic heads except where solution cavities are encountered
Warsaw Formation	Interbedded shale and limestone subject to Karst formation; weathers and slakes
Fern Glen Formation	Interbedded limestone and shale; project-related engineering characteristics similar to Salem Formation
Bushberg Formation	Massive, porous quartzose sandstone; aquifer; other project-related engineering characteristics similar to Salem Formation
MaquoKeta Formation	Shale with thin calcareous beds; easily weathered to clay; slakes; other project-related engineering characteristics similar to Salem Formation
Kimmswick Formation	Medium to massive beds of coarse limestone contain calcite-lined voids; other project-related engineering characteristics similar to Salem Formation
Loess	Aeolian overburden; stable vertically but highly erodable on slopes; highly permeable vertically
Residuum	When formed on St. Louis & Salem formations, well-structured plastic clay; high shrink-swell; moderate permeability. When formed on Warsaw shale, plastic organic clay with very low permeability; subject to creeping and rotational sliding on slopes. When formed on Burlington Formation; gravelly clay to chert gravel; granular, with about 45% sand; highly permeable
Alluvium of Larger Meramec Tributaries	Sandy; coarse-grained; high chert content; highly permeable; low bearing strength

NOTE: [(a)] Source: (016)

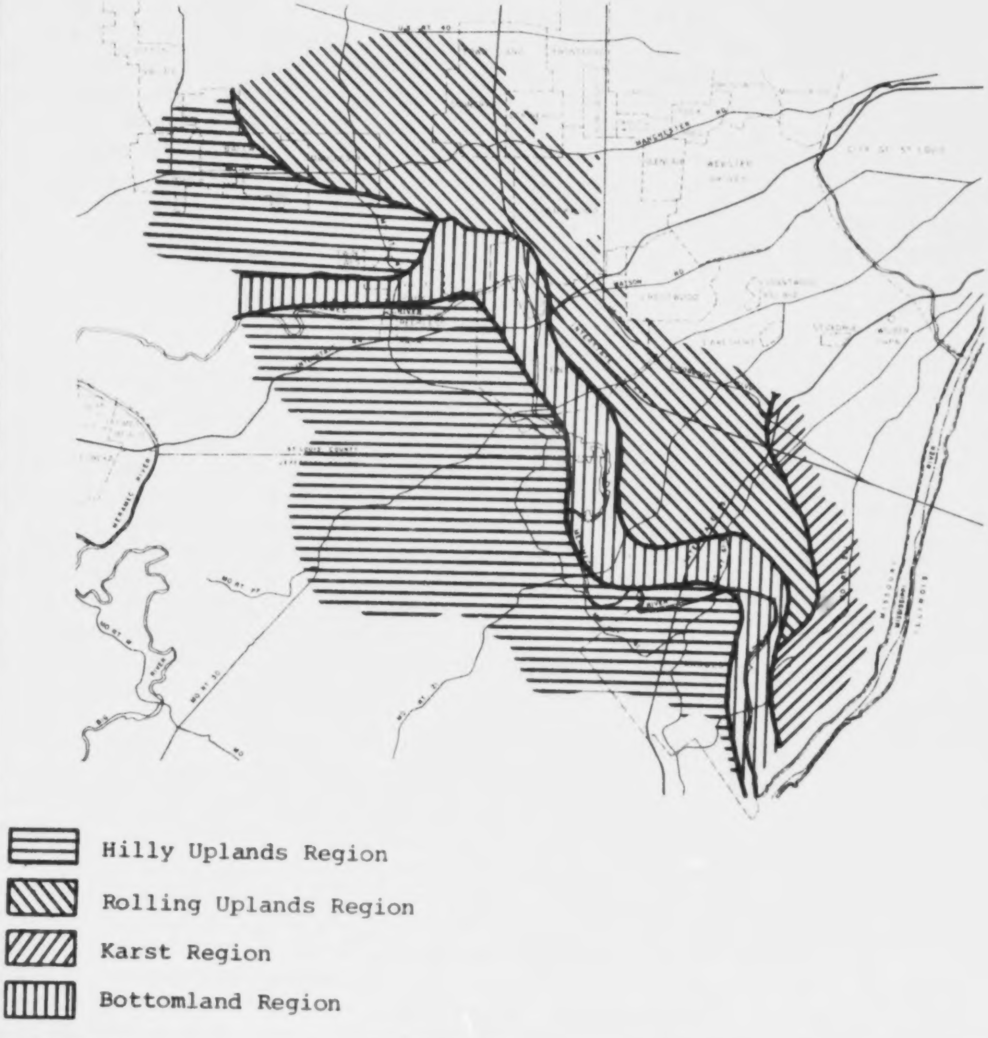
Hilly Uplands Region
Rolling Uplands Region
Karst Region
Bottomland Region

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FIGURE 10
TOPOGRAPHIC REGIONS

which are quite large. Several of these sinkholes are greater than 30 feet deep and two have elongated dimensions greater than 1,000 feet (015). Some of these sinkholes contain ponded water year-round. Several caves are also known to exist within this region. Drainage is generally through sub-surface channels in the bedrock.

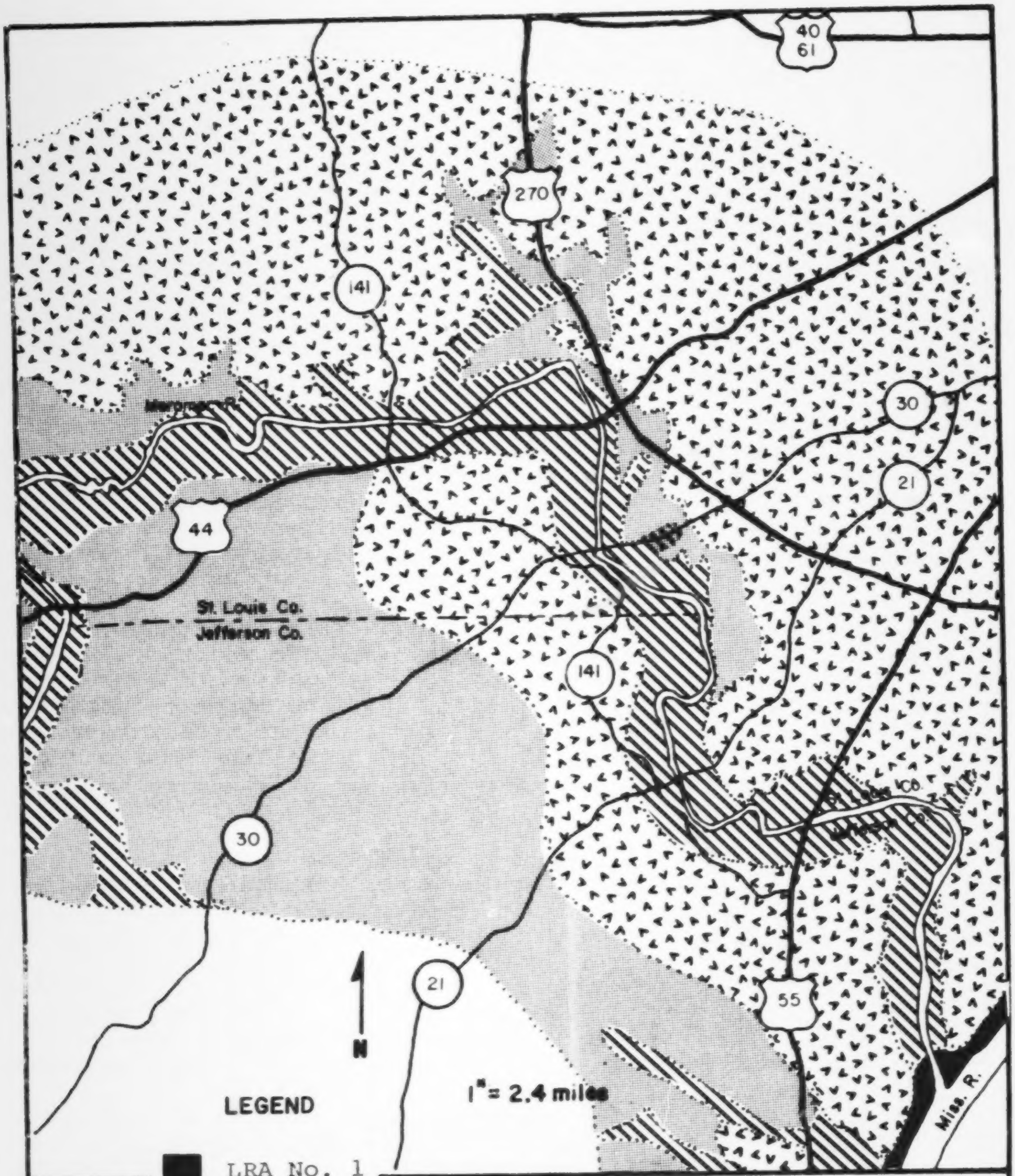
The Bottomland region encompasses all of the floodplain areas, alluvial terraces, and valley bottoms. Along the Meramec River the width of the bottomland varies from less than 1/2 mile to nearly 2 miles. The study area's lowest elevation (383 feet above sea level) is located in this region where the Meramec River joins the Mississippi River. All of the creeks tributary to the Meramec River have narrow areas of bottomland, generally too small to be shown in Figure 10. The average slope throughout the bottomland region is less than 5 percent. Almost all of the bottomlands are subject to periodic flooding, the most extensive of which is associated with backwater effects from the Mississippi River.

Soils

Up-to-date detailed soils maps have not been published for the study area. However, a detailed soil survey is underway for St. Louis County and interim interpretive information is available. In addition, a soils interpretation map with major "land resource area" (LRA) soil interpretations was prepared by the District office of the U. S. Department of Agriculture, Soil Conservation Service for the East-West Gateway Coordinating Council. These interpretations and the map were prepared for use as a basis for evaluating the capabilities of designated "LRA's" for various types of development. Information from these sources that pertain to the study area is summarized in the following paragraphs and the "land resource areas" are delineated on Figure 11.

Land Resource Area 1: Land River Floodplains - This land resource area is situated on the Mississippi River floodplain. Blake, Haynie, and Wabash are the major soil series. Wabash soils, occupying the lowest landscape positions, formed in clayey alluvium and are very poorly drained with very slow permeability. Blake soils, elevated slightly above the Wabash series, formed in stratified clayey and silty alluvium. Drainage is somewhat poor and permeability is moderately slow. Haynie soils, occupying the highest landscape position of the three, formed in loamy alluvium and are well-drained and moderately permeable. Native vegetation was forest and swamp grasses. Present land use is agricultural.

All of this land resource area is rated "poor" for community development. Major problems are wetness, high shrink-swell potential, low strength, and tendency toward frost-heaving. Approximately 75 percent of the area is rated "fair" for


40
61
270
141
30
21
44
Meramec R.
St. Louis Co.
Jefferson Co.
141
30
21
55
Miss. R.
N
1" = 2.4 miles

LEGEND

■ LRA No. 1
▨ LRA No. 2
░ LRA No. 3
∴ LRA No. 4

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FIGURE 11

SOILS INTERPRETATION MAP
LOWER MERAMEC RIVER BASIN

Source: (017)

recreation use, with 25 percent rated "poor". Major limitations are wetness, high clay content, and slow percolation. About 75 percent of this LRA is rated "good" for agriculture; 25 percent is rated "fair". The predominant limitation is wetness.

Land Resource Area 2: Small Stream Bottomlands and Terraces - This LRA occupies nearly level narrow bottomlands and terraces along the Meramec and small streams. The major soil series are Belknap, Nodaway, and Two-mile. All of these soils formed under forest cover in silty alluvium. Belknap soils are somewhat poorly drained and have moderately slow permeability. The well drained Nodaway soils have moderate permeability. The poorly drained Two-mile soils, situated on the terraces, have slow permeability. The major land uses in this LRA are cropping, pasturage, and timber production.

About 85 percent of this LRA is rated "poor" and 15 percent "fair" for community development. Predominant limitations are frost heaving and wetness. Fifty-five percent of the area is rated "fair" and 45 percent "poor" for recreation, with wetness cited as the chief problem. Sixty-five percent of the LRA is rated "good" and 35 percent "fair" for agricultural use, with wetness cited as the major limitation.

Land Resource Area 3: Rough Stony Land - This LRA occupies sloping to very steep landscape positions. The major soil series are Clarksville and Gasconade, Clarksville soils are very cherty, somewhat excessively drained, and have moderately rapid permeability. Gasconade soils are also somewhat excessively drained and stony and are shallow to bedrock. They have moderately slow permeability. Native vegetation on these soils was forest and present land use is primarily woodland.

Eighty-five percent of this LRA is rated "poor" and 15 percent "fair" for community development, with the main limitations being slope, depth to rock, frost action, stoniness, and shrink-swell. Eighty-five percent of the LRA is rated "poor" and 15 percent "fair" for recreation, with slope and stoniness the chief limitations. In terms of agricultural potential, 85 percent of this LRA is rated "very poor", 5 percent "poor", and 10 percent "fair", with slope, depth to bedrock, stoniness, and low available water capacity cited as the major limitations.

Land Resource Area 4: Deep Loess Uplands - Most future community development should be anticipated in this LRA, both in terms of the area's physical characteristics and in terms of its accessibility from the City of St. Louis.

This LRA occupies the hills adjacent to the Meramec and Mississippi floodplains. The landscape is dissected with gently to moderately sloping ridgetops and strongly-sloping to steep sided slopes. Menfro and Winfield are the major soil series. Both are silty soils formed in deep loess under forest cover. Both have moderate permeability. Menfro soils, generally nearest the floodplain, are well drained and Winfield soils are moderately well drained. Major land uses are pasturage, cropping, timber production, and urban development.

Seventy-five percent of this LRA is rated "fair" and 25 percent "poor" for community development. Major problems are sheet and gully erosion, frost action, steep slopes, shrink-swell, and wetness. Forty percent of the LRA is rated "good" for recreation, 45 percent is rated "fair", and 15 percent "poor". Slopes are the predominant limitation. Slope and erosion are the main limitations for agricultural use. Thirty percent of the LRA is rated "good" for agricultural use, 40 percent "fair" and 30 percent "poor".

LAND USE

Existing land use in the study area is shown on Figure 12. Land use by acreage is given in Table 5. Table 6 lists residential, commercial, and industrial establishments in St. Louis and Jefferson counties. (Table 6 is not restricted to the study area and serves only to illustrate regional characteristics as a basis for evaluating projected trends in the basin.) The economics section of this report presents additional information on development trends.

The following paragraphs deal with characteristics of existing land use patterns that are significant to this report.

Urban

Urban use accounts for the largest acreage of developed land in the study area. Urban development has occurred chiefly in areas of gentler topography (the areas coded "LRA 3 and 4" on Figure 11) and in areas near major transportation routes. The amount of land developed for urban use has increased rapidly in recent years.

TABLE 5

EXISTING LAND USE IN THE LOWER MERAMEC RIVER BASIN - 1970

Urban	1970 (acres)
Residential	21,680
Commercial	1,201
Industrial	1,088
Public	2,337
Recreation	4,905
Vacant	59,817
Transportation	121
Extraction	430
TOTAL	91,579

Source: (018, 019)

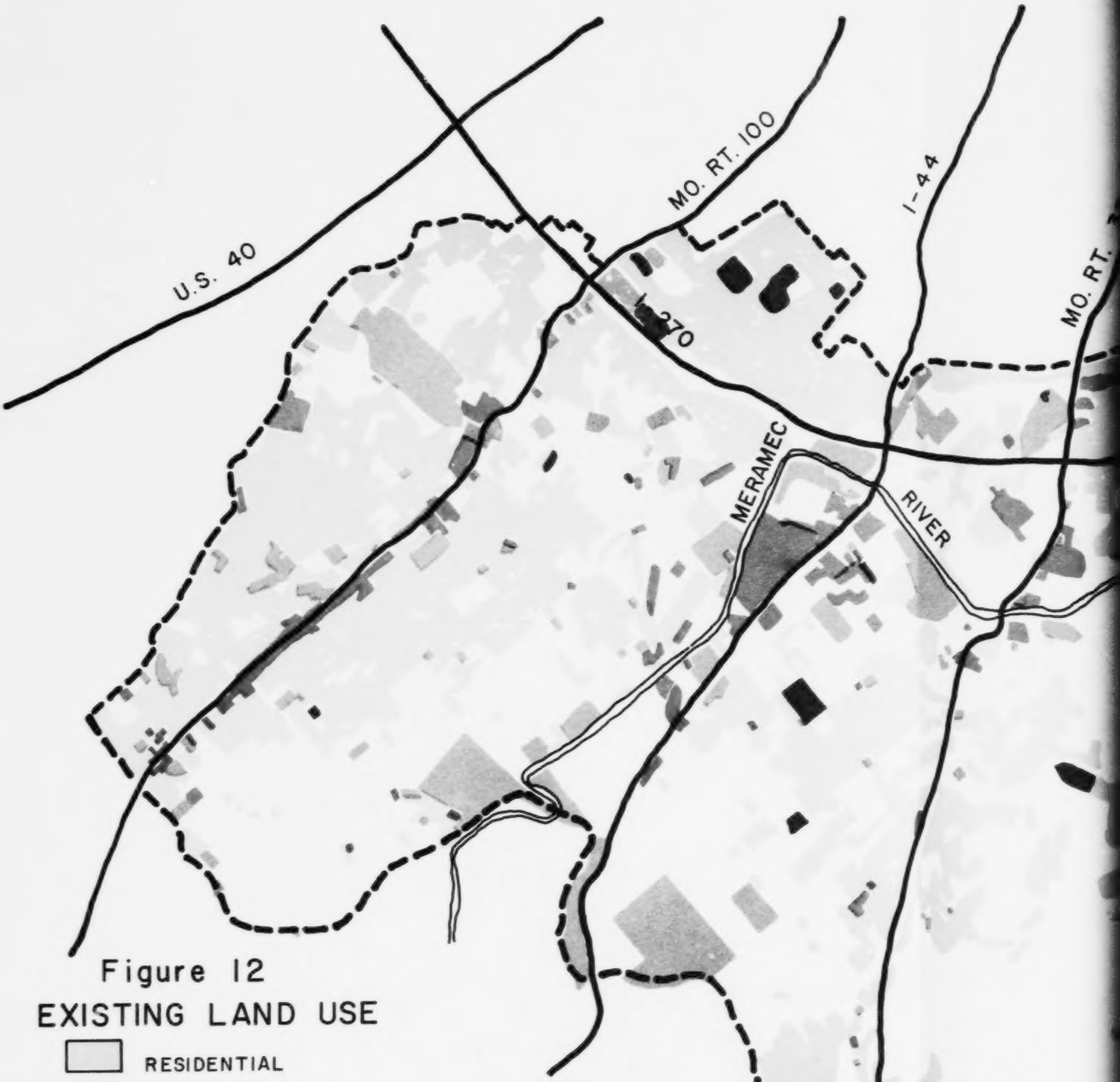
U.S. 40
MO. RT. 100
I-270
I-44
MO. RT.
MERAMEC
RIVER

Figure 12
EXISTING LAND USE

☐ RESIDENTIAL
▨ COMMERCIAL
▨ INDUSTRIAL
▨ PERMANENT OPEN SPACE
■ PUBLIC AND SEMI-PUBLIC
☐ AGRICULTURAL AND VACANT

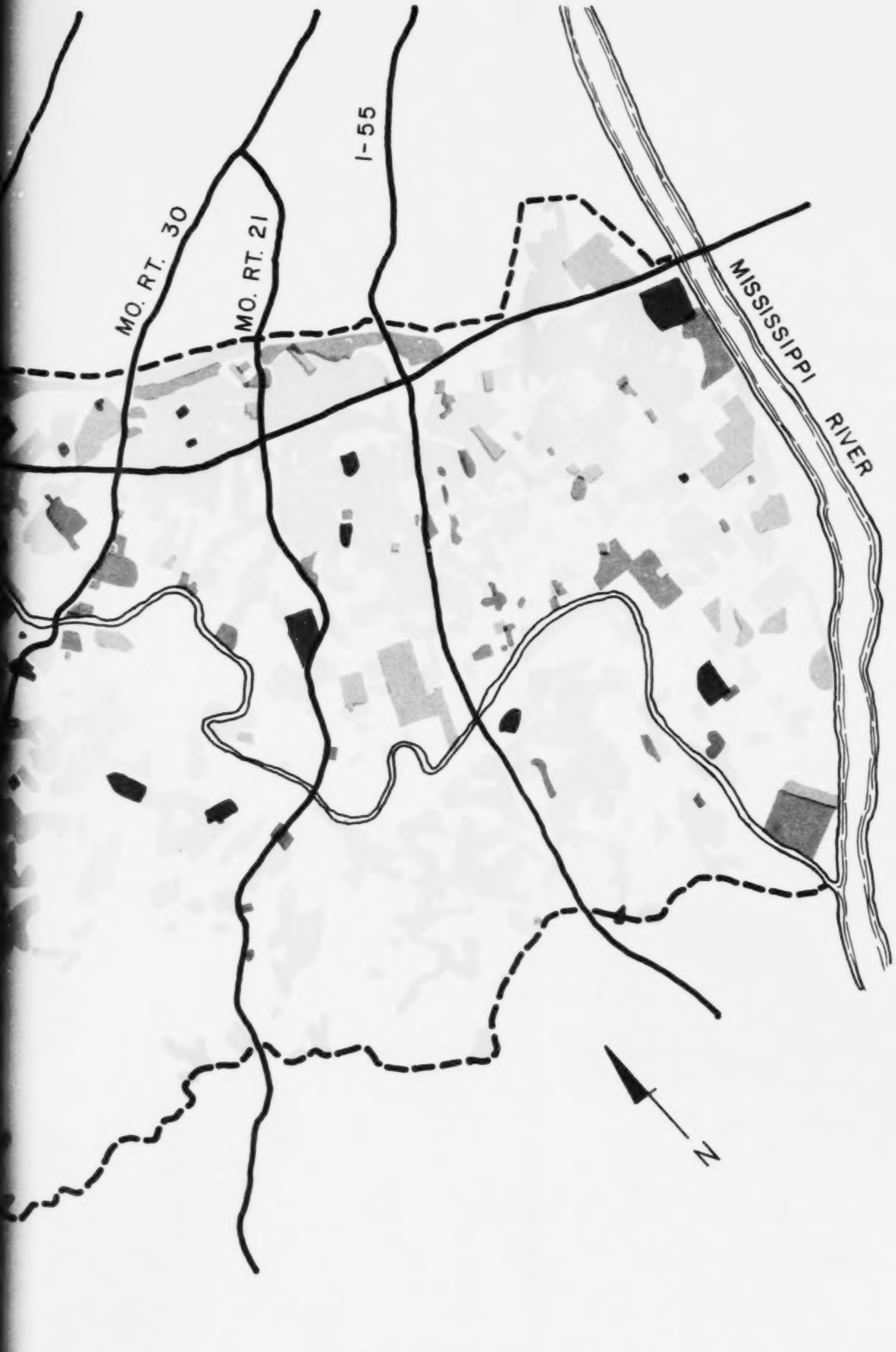
MO. RT. 30
MO. RT. 21
I-55
MISSISSIPPI RIVER
N

TABLE 6

URBAN LAND USE IN JEFFERSON AND ST. LOUIS COUNTIES, MO[(a)]

	1950	1954	1958	1960	1963	1967	1970
Jefferson County							
Residential Number of dwellings	13,219	--	--	22,074	--	--	33,677
Commercial Retail trade Number of establishments	--	--	582	--	--	646	--
Wholesale trade Number of establishments	--	--	--	--	54	51	--
Industrial Number of Establishments	--	33	35	--	--	50	--
St. Louis County & City							
Residential Number of dwellings	381,934	--	--	470,392	--	--	530,135
Commercial Retail trade Number of establishments	--	--	13,708	--	--	11,890	--
Wholesale trade Number of establishments	--	--	--	--	3,208	3,224	--
Industrial Number of establishments	--	2,649	2,608	--	--	2,519	--

NOTES: (a) -- Denotes data not available for particular years.

Source: (020)

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Approximately 92 percent of the acreage developed for urban use is residential, with the greatest growth increases occurring in St. Louis County. Most residential development in the basin is single-family housing, although multi-family units have also increased (021).

Much of the commercial development in the study area is small retail trade, with restaurants and bars, service stations, and grocery stores predominating. The recent trend has been toward development of large regional and moderate-sized shopping centers and "strip" commercial concentrations along major highways (022, 023). Both Jefferson and St. Louis Counties are important wholesale centers for their region. However there has been no major expansion of wholesale trade in Jefferson County since 1954 (021). Service establishments have increased in the basin. However, the most significant increase has occurred in the more heavily populated region to the study area's north.

In past years, much of the region's industrial development was located along major rivers because of the availability of cooling waters for industrial processes and because these locations were accessible to rail and river transportation. Although some industry still relies heavily on these transportation systems, much of the industrial development has been relocated to less expensive tracts, away from the core of the City of St. Louis, and is generally concentrated in planned industrial parks or industrial districts (022, 024). Most of this recent development has occurred along Interstate 44, Interstate 244 and Interstate 270 in St. Louis County and along Interstate 55 in Jefferson County.

The range of industries located in the study area is illustrated in Table 7, which lists types and numbers of manufacturing plants located in selected communities in the basin.

Public and Semi-Public Land Use

In 1970, approximately 2.5 percent of the study area's acreage was designated as public and semi-public (018, 019). Educational, health and religious facilities located in communities on which community profiles were available in the Lower Meramec River Basin are listed in Table 8.

TABLE 7

LOCAL MANUFACTURING CHARACTERISTICS OF SELECTED COMMUNITIES IN THE LOWER MERAMEC RIVER BASIN

County and Community	Number of Manufacturing Plants in Community	Major Manufacturers or Large Employers	Product(s) Manufactured
Jefferson County			
Arnold	6	Browning Arms Co.	Firearms & sporting goods
		Beacon Machinery	Automatic pallet loaders
		W-K Manufacturing Co.	Office furniture, refinishing
		L.W. Price Manufacturing Co.	Cabinets, furniture
St. Louis County			
Fenton	21	Chrysler Corp.	Autos & trucks
		Inland Container	Corrugated shipping containers
		Koller-Craft Plastics Products, Inc.	Compression, injection and blow molded plastics
		Multiplex Display Fixture Co.	Display and reference equipment
Kirkwood	11	Greif Brothers Corp.	Fiber drums, containers
		Mark Andy, Inc.	Flexigraph rotogravure, tape
		Kirkwood Fabricators	Metal fabrication
		Cox Ware	Permanent mold aluminum casting

Source: (025)

TABLE 8

EDUCATIONAL, HEALTH, AND RELIGIOUS FACILITIES IN COMMUNITIES OF THE LOWER MERAMEC RIVER BASIN

Arnold, MO, Jefferson County

1) Educational Facilities	
Public Schools	
Elementary Schools	6
Junior High Schools	2
High Schools	1
Trade & Technical Schools	Area Vocational Schools, St. Louis City and County - 20 miles
Junior Colleges	Jefferson County Junior College, Hillsboro, Missouri - 25 miles
4-Year Colleges	-
Universities	University of Missouri, St. Louis - 18 miles
Private Schools	
Elementary Schools	3
High Schools	-
Colleges	-
2) Hospitals	-
3) Churches	-

Fenton, MO, St. Louis County

1) Educational Facilities	
Public Schools	
Elementary Schools	1
Junior High Schools	1(a)
High Schools	1(a)
Trade & Technical Schools	1(a)
Junior Colleges	3 Junior Colleges in St. Louis County District
4-Year Colleges	-
Universities	University of Missouri, St. Louis - 20 miles
Private Schools	
Elementary Schools	2
High Schools	-
Colleges	14 Junior Colleges, Colleges and Universities in the County.
2) Hospitals	-
3) Churches	7

Kirkwood, MO, St. Louis County

1) Educational Facilities	
Public Schools	
Elementary Schools	11
Junior High Schools	2
High Schools	1
Trade & Technical Schools	Area Vocational School in County
Junior Colleges	3 Junior Colleges in St. Louis County District
4-Year Colleges	-
Universities	University of Missouri, St. Louis - adjacent
Private Schools	
Elementary Schools	3
High Schools	1
Colleges	1
2) Hospitals	1
3) Churches	15

NOTES: (a)Located outside city limits.

Source: (025)

Recreation

During the last decade there has been a tremendous increase in demand for recreational facilities near the St. Louis metropolitan area. Consequently, there has also been a continual trend in recent years towards seasonal resort development in the Meramec River Basin (021).

In 1970, approximately 5.4 percent of the study area's total acreage was designated for recreation. Recreational facilities in the study area are owned by federal, state, and local governments as well as private owners. The number and acreages of ownerships in St. Louis and Jefferson Counties, as of 1966, are presented in Table 9. It should be noted, however, that these figures only include developed facilities.

As shown in Table 9, most recreational areas in St. Louis County in 1966 were owned by local governments, while in Jefferson County, most facilities were owned by private sources. The greatest amount of acreage for recreational facilities is currently owned by St. Louis County, while most of the acreage in Jefferson County is privately owned. Locations of the major recreation sites in the study area are shown on Figure 13 (names are given in Table 10). A recreation inventory, by county, is given in Table 11 and a list of parks and facilities in the basin is listed in Table 12. Campground facilities are listed in Table 13.

Vacant Land

Approximately 65 percent of the land in the study area is undeveloped (018, 019). The lack of development on this land is due to a variety of limitations. The chief limitations are poor access, frequent flooding, steep slopes, Karst topography, and the high shrink-swell and frost heaving tendency of soils.

Transportation

On a total county basis, Jefferson County has approximately 332 total miles of highways including 28 miles of interstate, 49 miles of primary highway, and 255 miles of supplementary highways. St. Louis County, as a whole, has about 382 total miles of highway systems, including 108 miles of interstate, 42 miles of primary highway, and 232 miles of supplementary highways (026).

TABLE 9

NUMBER AND ACREAGE OF OUTDOOR RECREATION FACILITIES BY TYPE OF ADMINISTRATION AND TYPE OF OWNERSHIP

1966(a)

	St. Louis Co.	Jefferson Co.
10 acres or less	180	34
11 acres or more	137	47
Total	317	81
Number by Type of Administration		
Federal	1	0
State	5	2
County	22	1
Other Local Govt.	276	40
Private	13	38
Total	317(b)	81
Number by Type of Ownership		
Federal	1	0
State	3	2
County	22	1
Other Local Govt.	271	38
Quasi-Public	0	1
Private	17	39
Total	314(b)	81
Acreage by Administrative Agency		
Federal	0	0
State	5,588	5
County	45,707	2
Other Local Govt.	4,627	969
Private	552	2,385
Total	56,474(b)	3,361
Acreage by Ownership		
Federal	0	0
State	5,588	5
County	45,707	2
Other Local Govt.	4,466	614
Private	628	2,390
Quasi-Public	0	350
Total	56,389(b)	3,361

TABLE 9

NUMBER AND ACREAGE OF OUTDOOR RECREATION FACILITIES BY TYPE OF ADMINISTRATION AND TYPE OF OWNERSHIP

1966[a]

(continued)

NOTES: [a] Includes only developed facilities and resources.

[b] Totals computed from figures given in original source.

Source: (058)

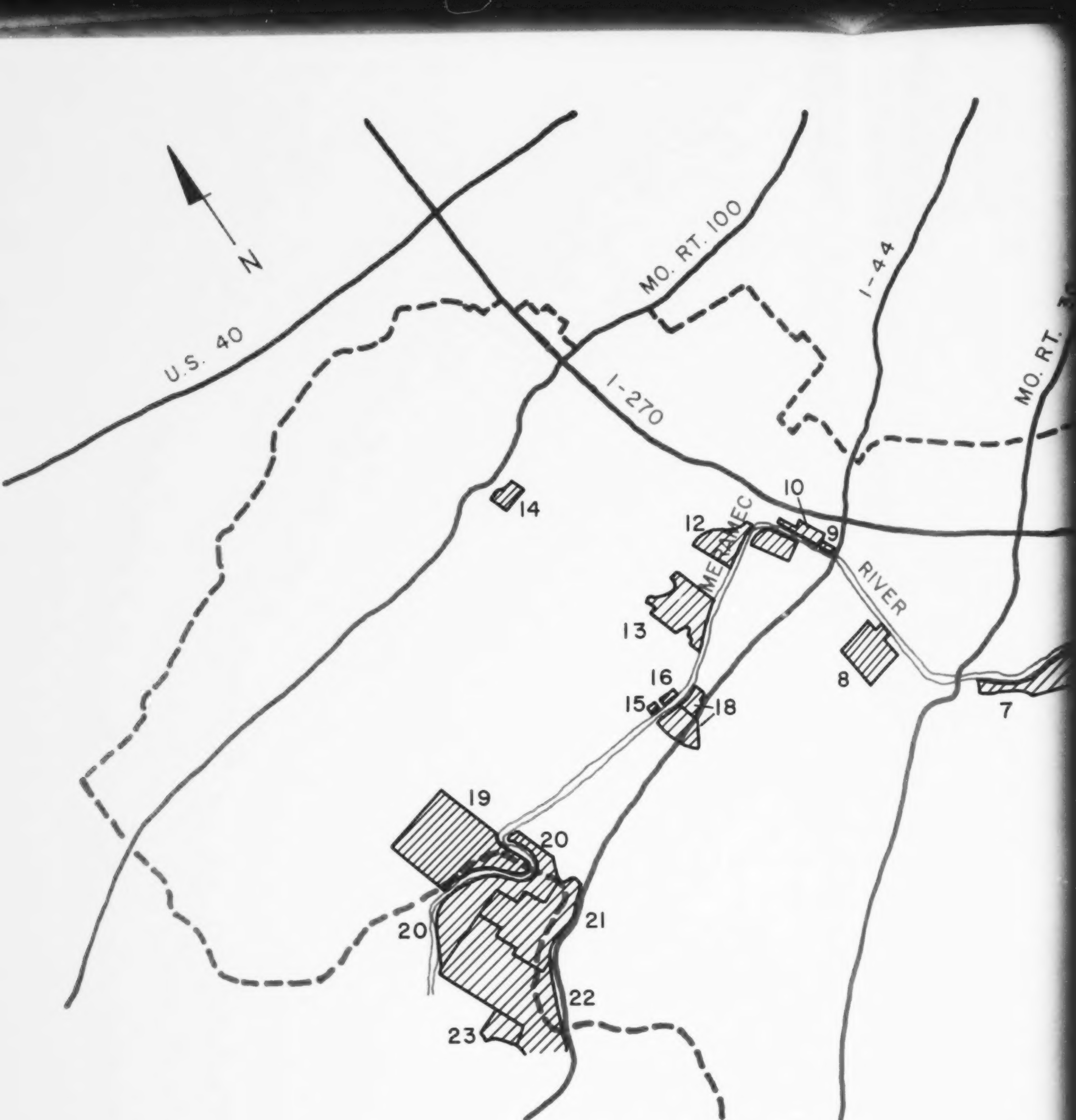
TABLE 10

PRINCIPAL RECREATION AREAS IN REGION DIRECTLY INFLUENCED BY ALTERNATE PROJECT ACTIVITIES

Recreation Area	Chief Recreational Opportunities Offered(a)
1. Bee Tree Park	Passive: T, P
2. Arnold Park (unnamed)	Undeveloped: Planned for combination of active/passive
3. Arnold City Park	Combination: P, PG, TC, C
4. South County Rec. Complex	Active: SW, SG, TC, P, T
5. Suson Park	Passive: F, P, PG
6. Winter Scenic Easement	Undeveloped: Planned for T, timber reserve
7. Winter Park	Combination: F, P, boat launching
8. Fenton City Park	Combination: P, PG, TC
9. Fontainbleau Park	Undeveloped: Planned for Active - TC, PG, SG, SW, rifle range
10. Emmenegger Park	Passive: T
11. Unger Park	Under Development: Passive - F, canoeing
12. Greentree Park	Active: P, SG, boat launching
13. Simpson Park	Under Development: Passive - F, canoeing
14. Love Park	Active: SG, PG, P, T
15, 16. Valley Park City Parks (unnamed)	Active: SG, P, PG
17. Recreation Easement	Passive: T
18. Buder Park	Active: SG, P, model airplanes
19. Castlewood State Park	Undeveloped, Planning not complete: boat launching
20, 21. Lone Elk Park	Passive: T, P, archery
22. Tyson Research Center	Passive: T, by reservation only
23. West Tyson Park	Passive: T, C, P
24. Sunset Park	Active

NOTE: (a)SG - sports/game fields
T - hiking trails
P - picnicking
PG - playground
TC - tennis courts
F - fishing
C - camping
SW - swimming pool

Source: (031, 032, 034, 035)


N
U.S. 40
MO. RT. 100
I-44
MO. RT. 3
I-270
MERAMEC
RIVER
10
12
9
14
13
8
16
15
18
7
19
20
20
21
22
23

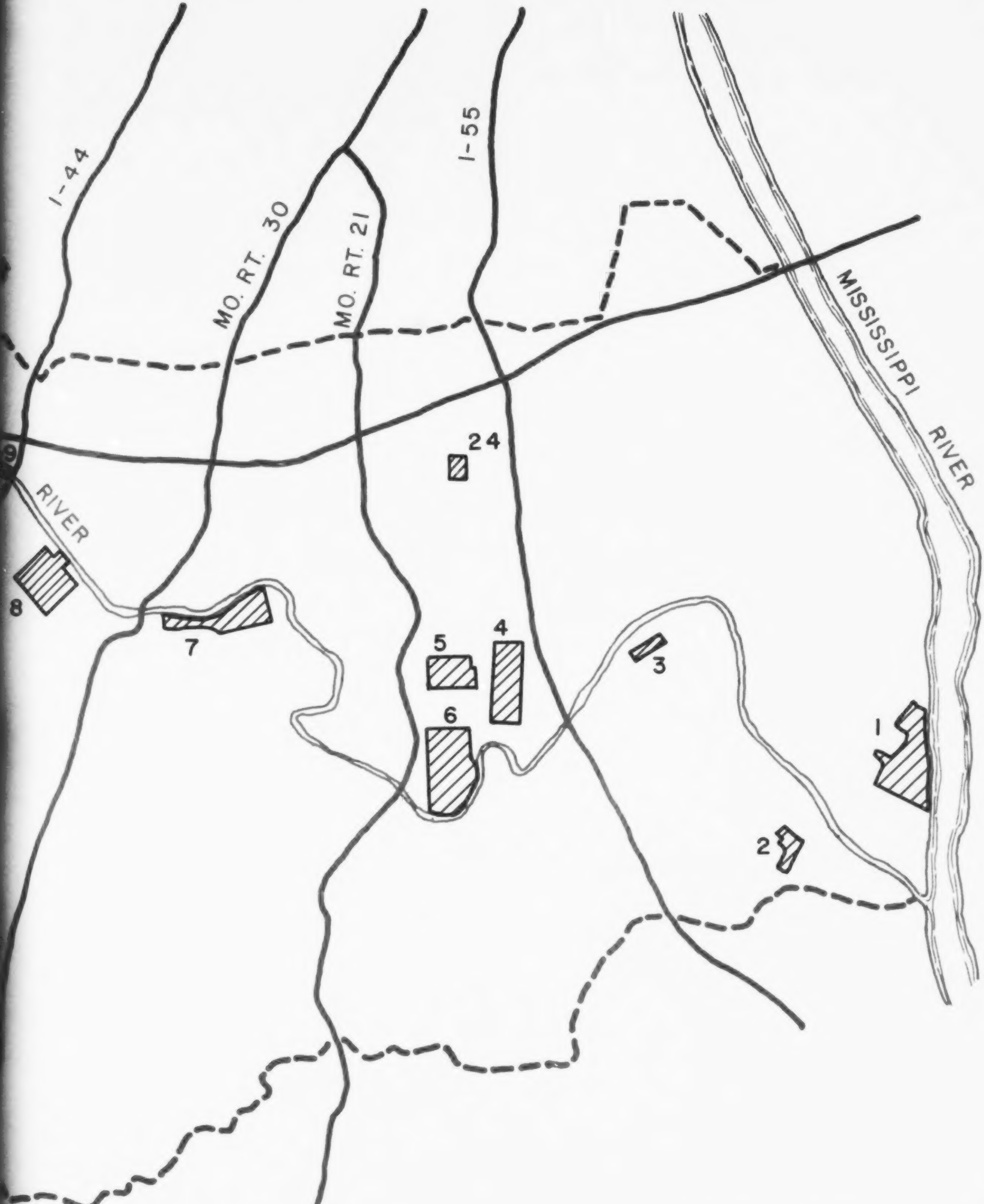

I-44
MO. RT. 30
MO. RT. 21
I-55
MISSISSIPPI RIVER
RIVER
9
24
8
7
5
4
6
3
1
2

FIGURE 13
PRINCIPAL RECREATION SITES

TABLE 11

RECREATION INVENTORY BY COUNTY
1970

	Jefferson Co.	St. Louis Co.
Bike Trails (miles)	0	10
Horse Trails (miles)	5	0
Playfields (acres)	166	28
Fishing (acres)	143	310
Boating (acres)	100	216
Sailing/Canoeing (acres)	28	61
Swimming (sq. ft.)	512,450	135,780
Hunting (acres)	0	1,190
Camping (acres)	360	14
Hiking (miles)	0	2
Picnic (acres)	102	47
Winter Sports (acres)	0	0

Source: (029)

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TABLE 12

PARKS AND FACILITIES IN THE
LOWER MERAMEC RIVER BASIN

Name of Park	Location	Size in Acres	Facilities	Comments
Beaumont Boy Scout Reservation	Interstate 44 and Beaumont-Antire Road, near Valley Park, Missouri	2,465	Swimming pool, archery range, rifle range, special group camping areas, bridle trails, chapel, health lodge, dining hall, meeting building.	Utilized primarily by Boy Scouts; other groups occasionally admitted, but members must not be older than the age limit for Boy Scouts.
Castlewood State Park	Keifer Creek Road, Castlewood	1,200	Planned for low-density recreational development.	Undeveloped.
Metropolitan Parks				
Bee Tree County Park	Becker and Finestone Roads in southern St. Louis County	195	Currently limited to picnicking and other passive recreation facilities, hiking trails, playground.	Future plans include picnic areas, lake, fishing, trails, visitor's building.
Buder County Park	Missouri Highway 141 and Interstate 44, near Valley Park, Missouri	168	Extensive model airplane fields, ball fields, two shelters, 12 picnic areas with barbeque facilities, multi-use fields.	Future plans include playgrounds, shelter house, multi-purpose courts, restrooms, parking area, landscaping, and 90-acre expansion.
Lone Elk County Park	Missouri Highway 141 and Barrett Station Road	405	Picnic areas, 26-acre lake, animal shelters, nature and bridle trails, and service facilities.	
Queeney Park and Recreation Complex	Mason Road and south of Clayton Road, central St. Louis County	570	2 ice rinks, concession stands, small ponds, fishing, children's playground, hiking and bike trails, bridle trails, swimming pool.	
South County Sports Complex	Meramec Bottom Road and Butler Hill Road near the Meramec River in the southeastern section of St. Louis County	264	Artificial ice skating rink, swimming pool, tennis courts, playground under development.	
George C. Winter Memorial Park	Allen Road, east of Highway 141	116.8	Boat ramps, parking areas, shelters, ball field.	
Simpson County Park	Marshall Road	174	Fishing lake.	Undeveloped.
Unger County Park	Yarnell Road	93	Lake, picnic shelter.	Under development.
Winter Scenic and Timber Easement	Meramec Bottom Road	162	Trails.	Undeveloped.

TABLE 12

PARKS AND FACILITIES IN THE LOWER MERAMEC RIVER BASIN
(Continued)

Name of Park	Location	Size in Acres	Facilities	Comments
District Parks				
Kirkwood Park	Adams Avenue and Geyer Road	80	Games and sports (baseball diamonds, tennis courts), children's playground, picnic area, amphitheater, ice rink.	
Greentree Park	Marshall Road	84	Picnic areas, shelters, ball diamonds, boat ramp.	
Manchester Park	Old Meramec Station and Hanna Roads	44	Swimming pool, tennis courts, baseball diamonds, children's playground, picnic area.	
Emmenegger Park	Geyer Road	94	Hiking trails.	
FontaineBleau	Stoneywood Drive	14.5	Tennis courts, playground, ball diamonds, swimming pool, concession building, multi-use building, rifle range.	
Fenton City Park	Yarnell Road	90	Picnic shelters, playground, ball diamonds, tennis courts, multi-use building.	
Sunset Hills Henry H. Laumeier Memorial County Park	Rott and Geyer Roads	74	Hiking trails, picnic shelter, sculpture garden.	
Unincorporated Love County Park	Mason Lane, south of Manchester Road	48	Ballfields, playground, picnic areas, athletic fields, hiking trails, picnic shelter.	
Suson County Park	Wells Road, south of Highway 21	87	Farm animal zoo, fee fishing, pond, picnic site.	
Arnold City Park		52	Picnic shelter, playground, lake.	
Neighborhood Parks				
Ballwin Vlasis Park	219 Manchester Road	12	Football fields, baseball diamonds, tennis courts, picnic area, children's play area, pavilion, fishing pond.	

TABLE 12

PARKS AND FACILITIES IN THE LOWER MERAMEC RIVER BASIN
(Continued)

Name of Park	Location	Size in Acres	Facilities	Comments
Des Peres Pioneer County Park	Tallie Drive, south of Manchester Road	7	Tennis courts, athletic fields, picnic shelter, playground.	
Ellisville Bobwhite Park	Salem Way and Reinke Roads	2.5	Picnic area, children's playground.	
Mockingbird Park	Bridgeport and Cherry Hill Drives	6.0	Children's playground, picnic areas.	
Ranchmoor Park	Ranchmoor Drive off Corral Drive	4.4	Games and sports, children's play area.	
Whipporwill Park	Macklin Avenue	3.0	Children's play area, picnic area.	
Fenton Unnamed	Valiant Drive and Larkin-Williams Road	2.0	Baseball diamond, children's play area, tennis courts.	
Riverside Park	Second Street and St. Louis Avenue	5.0	Games and sports, shelter.	
Unnamed	Fifth Street and St. Louis Avenue	5.0	Games and sports.	
Unincorporated George E. Bohrer Memorial Concord Village County Park	Lindbergh Blvd. and Lin-Ferry Road	15.0	Ball diamonds, tennis courts, picnic area, shelter, children's play area, pond.	
Winchester Winchester Park	N.A.	5.0	Games and sports, picnic area.	
Vest-Pocket Parks				
Fenton Unnamed	Larkin-Williams Road and Riverside Drive	1.0	Tennis courts, basketball court.	
Totlots				
Kirkwood Kirkwood Park #2	Clay and Madison Avenue	0.5	Children's play area.	
Sunset Hills City Park	Kayburn Avenue and Lynstone Drive	1.0	Children's play area.	

Source: (030, 031, 032, 033, 034, 035)

TABLE 13

CAMPGROUND FACILITIES LOCATED IN THE LOWER MERAMEC RIVER BASIN

Name of Park	Access	Physical Environment	Bottled Gas	Air Conditioning	Tables	Firewood	Pull-thru Spaces	Recreation Hall	Flush Toilets	Showers	Ice	Laundry	Cafe - Snack Bar	Store	Swimming Pool	Other Swimming	Fishing	Boating	Playground	Other
McConnell's Park Campsite	Exit Lindbergh Blvd. to Big Bend Rd., 1-3/4 mi. W., 1 mile S. on Marshall Rd., 1 mile E. to campground	Access to river; rural area	no	extra chrg.	yes	no	no	no	yes	yes	no	no	within 1 mile of campground	no	no	no	no	no	no	motor bikes permitted

Name of Park	Elevation	Acres	No. of Tent Spaces	Minimum Fee	No. of Trailer Spaces	Minimum Fee	Season	Time Limit	Reservations	Pets Permitted	Maximum Trailer Size	Electric Hookup	Water Hookup	Sewer Hookup	Sanitary Station
McConnell's Park Campsite	1	3	10	$3.00	24	$3.50	all year	14	reservations accepted	yes	no limit	yes	no	no	yes

Source: (036)

In 1970, approximately 121 acres of land in the Lower Meramec River Basin were designated for transportation land use (018, 019). At present, there are approximately 11 major highways serving the study area, four federal highways (three interstates, one U.S. highway) and seven state highways (027, 028). Both Interstate 55 and U.S. Highway 61 and 67 are federally owned but maintained by the State of Missouri (027). Major thoroughfares serving the Lower Meramec River Basin are shown in Figure 14.

Seven major state highways traverse the study area. They are:

1. Route 30 (Gravois Road) extends from the St. Louis area through Jefferson County; in the study area it is a multi-lane facility running in an east-west direction.
2. Route 21 (Tesson Ferry Road) extends from the St. Louis area through the study area in Jefferson County in a north-south direction; it is a multi-lane highway north of its intersection with Route 141, and becomes a two-lane facility south of this point.
3. Route 100 (Manchester Road) is a multi-lane facility serving the St. Louis County in an east-west direction.
4. Route 141 serves both Jefferson and St. Louis Counties and runs north-south.
5. Route 231 (Telegraph Road) runs north-south through St. Louis and Jefferson Counties, roughly paralleling the Mississippi River.
6. Route 267 (Lemay Ferry Road) serves St. Louis County, traversing the eastern portion in a north-south direction.
7. Route 366 (Watson Road) traverses St. Louis County in an east-west direction; only a small portion is included in the study area (027, 028).

Other major highways traversing the study area are as follows:

1. Interstate 55, a major north-south limited access highway through the central U.S., passes through the southeast edge of the study area, crossing the Meramec near Arnold.

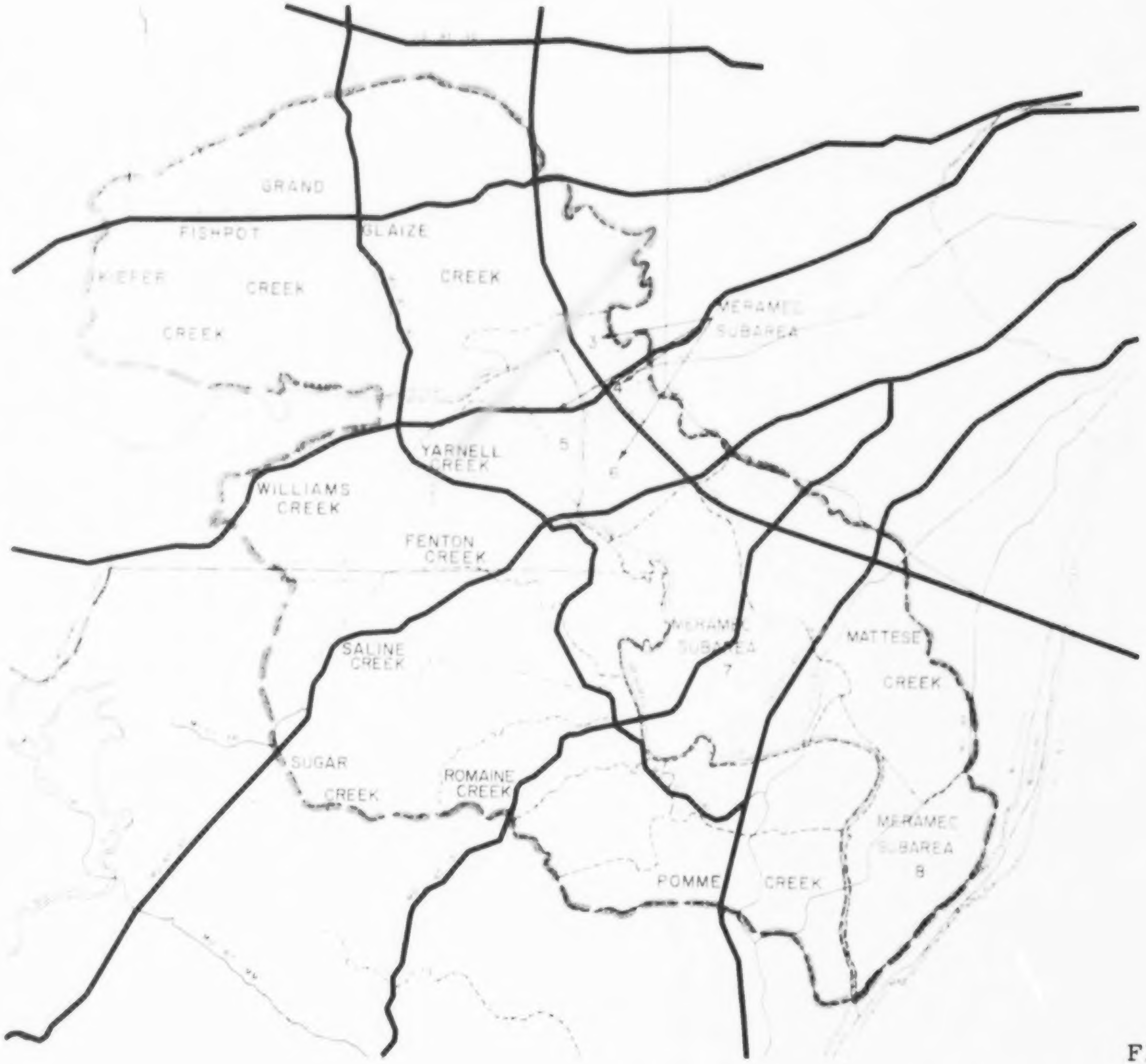
GRAND
FISHPOT
GLAIZE
CREEK
KIEFER
CREEK
CREEK
CREEK
MERAMEC SUBAREA
3
YARNELL CREEK
5
6
WILLIAMS CREEK
FENTON CREEK
MERAMEC SUBAREA 7
MATTESE
CREEK
SALINE CREEK
SUGAR
CREEK
ROMAINE CREEK
MERAMEC SUBAREA 8
POMME
CREEK

FIGURE 14
MAJOR TRANSPORTATION ROUTES

2. Interstate 44, a major east-west limited access highway running from St. Louis (where it connects with Interstate 55, Interstate 70, and Interstate 64) westward, traverses the northwest part of the study area, crossing the Meramec in Sunset Hills and again, farther westward, at Times Beach.

3. Interstate Bypass/Connector 270 connecting Interstates 70, 44, and 55 around St. Louis' west side and providing north-south access in west St. Louis County, passes through the northern and northwestern parts of the study area.

4. U.S. Route 40 (Daniel Boone Expressway), a multi-lane arterial running east-west through St. Louis, runs just north of the study area.

5. U.S. Route 61 (Lindbergh Boulevard), a multi-lane north-south arterial in south St. Louis and Jefferson County, traverses the northeastern edge of the study area and trends southward through the area's south-central portion, crossing the Meramec River near Arnold.

6. U.S. Route 67, synonymous with Route 61 in the study area, is a multi-lane north-south arterial serving St. Louis and Jefferson counties.

7. U.S. Routes 50 and 66 (Watson Road), joined in the study area, are multi-laned east-west arterials through St. Louis and St. Louis County. Route 66 was a major east-west artery through the central United States prior to the construction of Interstate 55 and Interstate 44. Watson Road passes through the northeast edge of the study area.

Approximately 59 truck lines and six bus lines serve St. Louis County. Generally, commercial air travel between points in the study area is extremely limited. Although no airlines currently serve Jefferson County, small municipal airports and private landing fields have been developed to meet the demand for charter and private planes. Lambert Field in St. Louis serves both Jefferson and St. Louis Counties, but is not located in the study area. At the present time, six railroads serve St. Louis County and three, Jefferson County (020). Trunk line railroads serving St. Louis County include: 1) Burlington Northern, Inc.; 2) Frisco Railway (St. Louis - San Francisco Railway Company);3) Missouri Pacific Lines; 4) Norfolk and Western Railway Company; and 5) Rock Island Lines (Chicago, Rock Island and Pacific Railroad Company) (037).

Extractive Land Use

Extractive land use, which includes both agricultural and mining activities, occupies approximately 430 acres in the Lower Meramec River Basin (018, 019).

Agriculture - Tables 14, 15, and 16 indicate the following trends in agriculture in St. Louis and Jefferson Counties during the period from 1959 to 1969:

1) Decrease in number of farms;
2) Increase in average farm size;
3) Decrease in acreage actually harvested; and
4) Decrease in crop production.

These trends are most pronounced in St. Louis County largely due to encroachment by urban development. Most farms in the region are operated by part-time farmers (022).

Mining - The Meramec Basin has a vast supply of mineral resources including lead and iron (the two most important) in addition to stone, barite, clay, sand and gravel (021). The Southwest Missouri Lead District, the largest lead-producing region in Missouri, includes portions of St. Louis County and most of Jefferson County. Sand, gravel, and stone extraction constitutes the majority of mineral production in St. Louis County. From Valley Park (river mile 22) to the Mississippi River (river mile 0), gravel is mined from the stream bed, banks and floodplain. The thickest gravel beds lie southeast of Fenton, about 15 miles upstream from the confluence of the Meramec and Mississippi Rivers. Winter Brothers Materials Company is the major operator in this area. Simpson Sand and Gravel Company on Grand Glaize Creek is located about 6 miles upstream from the Winter Brothers operation (003).

St. Louis County has a total of 13 sand and gravel producers and 11 stone producers. The St. Louis metropolitan area has been the major source of stone production (25 percent of the total annual value of mineral production) in Missouri since 1960. St. Louis County is one of Missouri's largest limestone producers. In 1969, Jefferson County had six stone producers and three sand and gravel operators. Producers reporting mineral production in 1969 are listed, by county and commodity, in Table 17.

TABLE 14
FARM CHARACTERISTICS AND CROP PRODUCTION
JEFFERSON COUNTY, MO
1959, 1964, 1969

FARM CHARACTERISTICS	1959	1964	1969
Number of Farms	1,200	840	911
Average Value per Farm ($)	18,595	33,623	54,943
Cropland Harvested (acres)	43,377	33,946	27,506
Farms Selling More than $5,000 of Products	183	177	196
Average Age of Farm Operators (yrs)	53.7	55.6	54.3
Average Size of Farms (acres)	162.7	197.4	187.4
All Products Sold ($)	3,573,865	3,689,950	4,839,579
All Crops Sold ($)	810,215	822,262	764,840
All Livestock Sold ($)	2,763,650	2,835,310	4,035,700

CROP PRODUCTION	1960	1964	1969
Corn (bushels)	921,500	377,555	226,833
Wheat (bushels)	185,900	148,545	116,391
Soybeans (bushels)	49,600	39,310	49,044
Hay (tons)	31,400	26,959	28,548

Source: (020)

TABLE 15

FARM CHARACTERISTICS AND CROP PRODUCTION
ST. LOUIS COUNTY, MO
1959, 1964, 1969

FARM CHARACTERISTICS	1959	1964	1969
Number of Farms	1,235	706	717
Average Value per Farm ($)	61,240	118,935	129,519
Cropland Harvested (acres)	63,549	44,838	35,460
Farms Selling More than $5,000 of Products	370	254	271
Average Age of Farm Operators (yrs)	54.8	55.6	53.9
Average Size of Farms (acres)	95.6	117.2	141.3
All Products Sold ($)	8,196,301	7,609,650	8,101,909
All Crops Sold ($)	6,484,551	6,281,969	6,466,265
All Livestock Sold ($)	1,711,750	1,251,727	1,632,615

CROP PRODUCTION	1960	1964	1969
Corn (bushels)	1,160,100	953,165	706,060
Wheat (bushels)	588,000	536,375	365,637
Soybeans (bushels)	279,100	247,795	227,428
Hay (tons)	13,400	7,433	9,093

Source: (020)

TABLE 16

AGRICULTURAL USES
ST. LOUIS & JEFFERSON COUNTIES
1959-1969

	1959 (acres)	1964 (acres)	1969 (acres)
Jefferson County, MO			
Hay	9,191	14,278	14,634
Corn	12,624	9,938	5,007
Wheat	3,624	4,474	3,844
Soybeans	2,395	2,391	1,948
All Other Crops	4,775	2,865	2,073
St. Louis County, MO			
Hay	3,551	3,953	3,797
Corn	18,961	13,172	10,544
Wheat	17,455	15,049	10,516
Soybeans	11,605	11,239	8,030
All Other Crops	6,466	1,425	2,573

Source: (020)

TABLE 17

MINERAL PRODUCTION IN THE MERAMEC BASIN[a]

1969

County	Cement	Clay & Shale[b]	Sand & Gravel[c]	Stone[d]
Jefferson	1	1	3	6
St. Louis	2	4	13	11

NOTES:
[a] Some companies operate in more than one county.
[b] Mined for refractories, brick, tile and cement manufacturing.
[c] Includes industrial sand.
[d] Includes stone used in manufacture of cement and lime.

Source: (038)

Forested Land Use

Jefferson and St. Louis Counties combined have approximately 288,700 acres of forested land; 68,900 acres in St. Louis County and 219,800 acres in Jefferson County (021). Although forest acreage figures were not available for the Lower Meramec River Basin, most of the existing timber acreage will generally remain in forest areas since the majority of the land is not suitable for other uses. The amount of woodland acreage on farms in Jefferson and St. Louis Counties is presented in Table 18.

TABLE 18

TOTAL ACREAGE OF WOODLAND ON FARMS,
1959, 1964, 1969

	1959	1964	1969
Jefferson County	82,938	71,558	71,684
St. Louis County	19,993	14,062	22,223

Source: (020)

The main tree species used for timber in the basin area are white oak and red oak. Hickory, elm, softwoods, and black walnut are utilized to a lesser extent (021,039). Net timber volumes of live merchantable sawtimber trees for 1963 in Jefferson and St. Louis Counties are given in Table 19. Potential forest acreage demands are expected to rise with the increase in products requiring wood, such as hardwood flooring, pallets, and construction lumber.

Future Land Use

Land use projected in the study area for 1995 is shown on Figure 15. Categories used for this map are "service areas," rather than land use categories. A "service area" is defined as a relatively homogenous area in terms of land use intensity and development patterns and is used as an instrument for measuring future development levels (040). The projections on which the 1995 plan is based assume the Columbia - Waterloo Airport (on the Illinois side of the Mississippi) will be developed and will be the major airport serving the St. Louis area. The development of the airport would undoubtedly accelerate and, to some degree, intensify urban development in the study area. However, due to the pressures currently exerted on

TABLE 19

NET TIMBER VOLUME OF LIVE MERCHANTABLE SAWTIMBER TREES - 1963[a]

County	All Species	Softwoods	White Oaks	Black & Red Oaks	Black Walnut	Hickory, Elm, Others
Jefferson	143.5	2.4	78.3	31.3	2.7	28.8
St. Louis	73.3	0.1	35.2	19.4	1.0	17.6
Total	216.8	2.5	113.5	50.7	3.7	46.4

NOTES: [a] In million board feet

Source: (041)

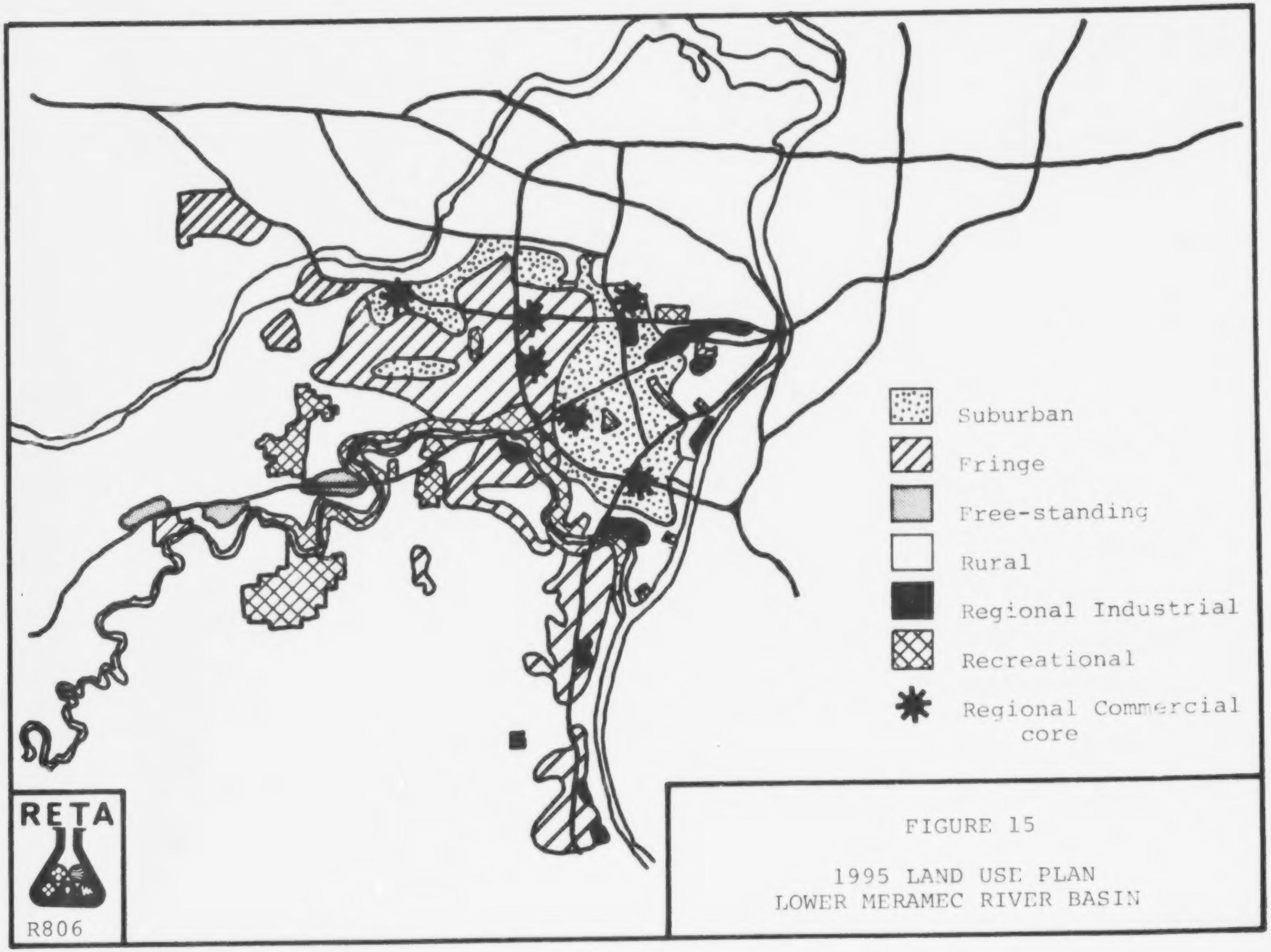
Suburban
Fringe
Free-standing
Rural
Regional Industrial
Recreational
Regional Commercial core
RETA
R806

FIGURE 15

1995 LAND USE PLAN
LOWER MERAMEC RIVER BASIN

the study area by the St. Louis area's growth as well as physical limitations on cost-effective development of the study area, it is unlikely that long-term growth patterns in the Lower Meramec Basin would be altered appreciably if the airport were not developed. Significant developmental trends in the study area are shown in Figure 15 and Table 20.

The amount of land devoted to residential use is expected to increase in the study area. However, the intensity and concentration of development (i.e. chiefly single- and multi-family housing) in the parts of the study area which are most physically suited for development and along major transportation routes are projected to follow historic trends. Commercial growth will probably continue to be centered around major transportation routes. The trend toward larger, more efficient shopping centers will probably continue also. Industrial growth is projected to take the form of industrial parks. The development of two concentrated industrial areas is predicted for the study area, one at the intersection of Interstates 44 and 244 and another adjacent to Interstate 55, near its crossing of the Meramec.

Numerous studies have reported a serious need in the St. Louis area for additional recreational areas to meet the increasing demand for such facilities. The Lower Meramec River Basin has the potential to meet this demand. In 1969, the East-West Gateway Coordinating Council (030) estimated that the St. Louis area would have to develop some 92,285 acres, or triple its current outdoor recreational acreage, to meet these increased demands. Proposed recreation areas for the Lower Meramec River Basin are shown in Figure 16. Proposed recreational facilities are listed in Table 21.

The Meramec Recreation Area proposed by the Missouri Department of Natural Resources includes the area along the Meramec River from Meramec Springs Park to the mouth of the Meramec River at the Mississippi River. Total acreage is approximately 55,000 to 60,000 acres (031, 034, 035). Some of the remaining proposed facilities will serve municipalities within the basin and in southern St. Louis and northern Jefferson Counties (032).

Transportation (Future) - On March 27, 1974, the Board of Directors of the East-West Gateway Coordinating Council adopted the 1995 Highway and Transit Plan for the St. Louis area which includes the Lower Meramec River Basin study area. The plan calls for construction of 184 miles of new highways, improvements to 590 miles of existing highways, implementation of an 86-mile high-capacity transit system, and expansion of the sur-

TABLE 20

PROJECTED LAND USE IN THE LOWER MERAMEC RIVER BASIN 1980 AND 1995

Urban	1980 (acres)	1995 (acres)
Residential	25,145	30,842
Commercial	1,514	1,990
Industrial	1,171	1,285
Public	2,415	2,545
Recreation	5,467	6,303
Vacant	55,324	48,070
Transportation	113	114
Extraction	430	430
TOTAL	91,579	91,579

Source: (018, 019)

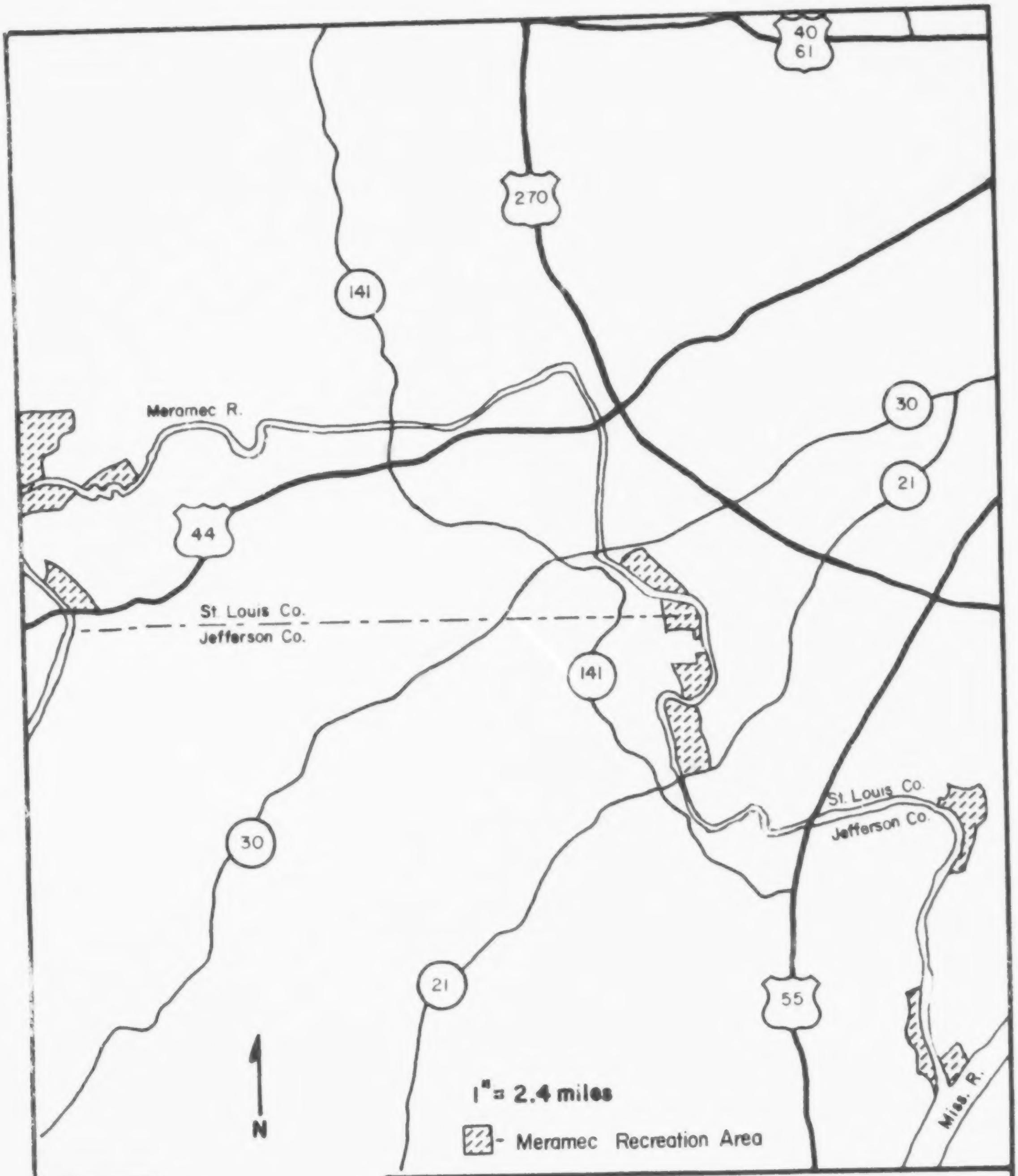
40
61
270
141
Meramec R.
30
21
44
St. Louis Co.
Jefferson Co.
141
St. Louis Co.
Jefferson Co.
30
21
55
Miss. R.
N
1" = 2.4 miles
▨ - Meramec Recreation Area

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FIGURE 16

MAJOR POTENTIAL RECREATION AREAS - LOWER MERAMEC RIVER BASIN

Source: (032)

TABLE 21

PROPOSED RECREATION FACILITIES IN THE LOWER MERAMEC BASIN

Name of Park	Location	Size in Acres	Proposed Facilities	Comments
Carmel Woods Park	Carmel Woods Drive near Keifer *Creek Pond in Ellisville*	18	Undeveloped	Municipal
Ellisville City Park	Polaris Drive in Ellisville	2.5	Undeveloped	Municipal
Kirkwood Park #3	Big Bend Road and Couch Avenue	3.0	Undeveloped	Municipal
Marshell Park	Not available (in Kirkwood)	3.0	Undeveloped	Municipal
Meramec National Recreation Area	From Meramec Springs Park near St. James, MO, to the mouth of the Meramec River where it empties into the Mississippi River	Approx. 55,000 to 60,000	Camping areas, picnic facilities, marinas, canoeing, boat launching ramps, fishing, sand beaches, athletic fields, lookout towers, scenic roads, hiking trails, nature study areas, horseback riding trails, information center.	State; due for completion in 1985 or 1990; main emphasis on protecting the river corridor; MNRA is totally separate from Meramec Dam issue and in no way hinges on final status of the Dam.

Source: (031, 032, 033, 034, 035)

face bus system to 2,720 route-miles (042). Most of the highway improvements are proposed for outlying areas, while the high-capacity transit system, and surface bus system are planned for the central core of the City of St. Louis. As it is not feasible to immediately implement all of these plans, a first-phase program will include construction of 60 miles of new highways, improvements to 300 miles of existing highways, improvements to the existing bus system, and plan refinement to allow for implementation of an 86-mile high-capacity transit system (042). Major new construction and improvements planned for the study area's highway system are shown in Figure 17.

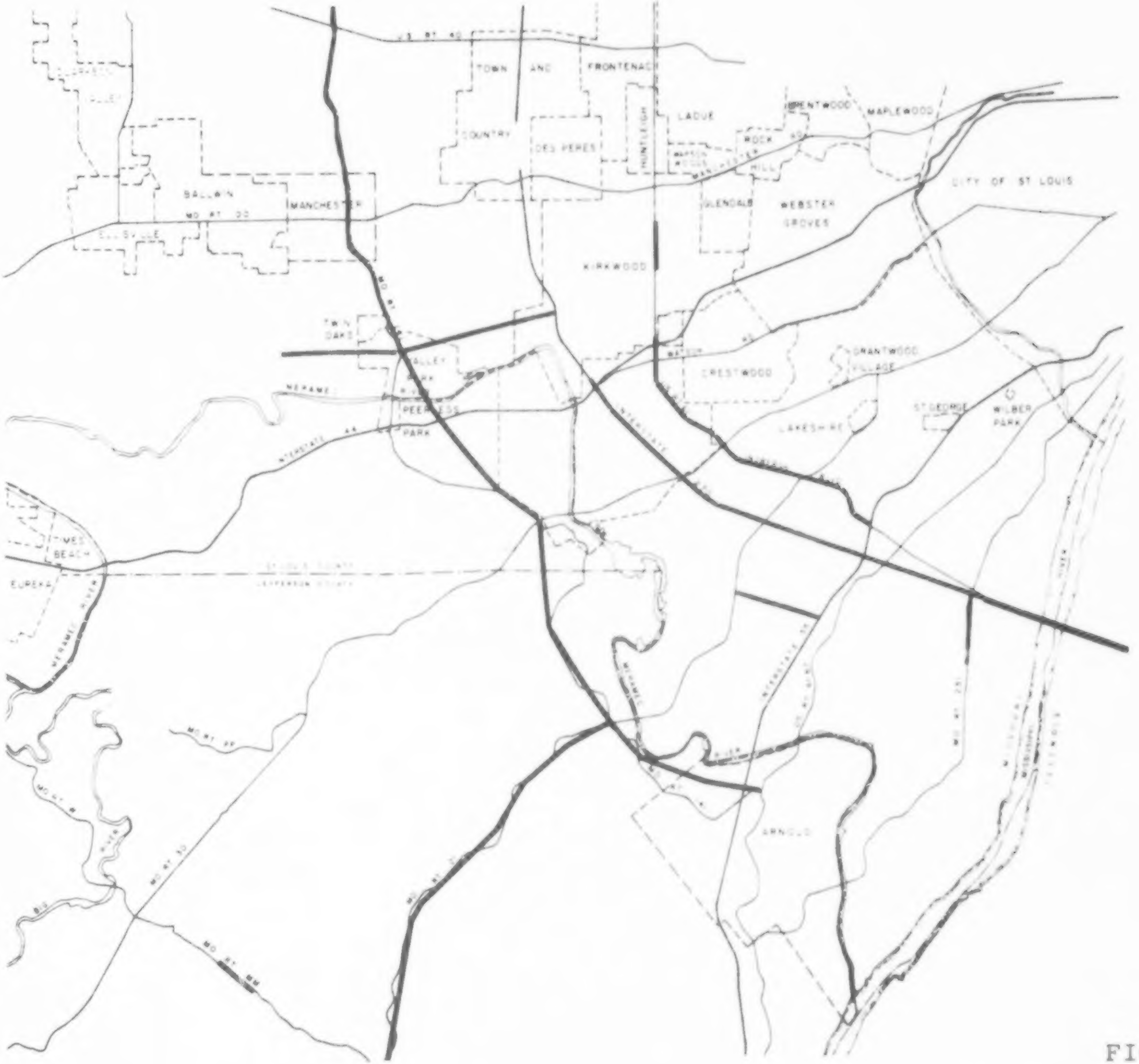
Planning and Zoning

Much of the development in the Lower Meramec Basin has been carried out with little regard for planning and zoning. Areas subject to flooding have been developed for incompatible uses. Landscape reshaping and paving have led to excessive erosion, ponding in level areas and short-duration flooding. Adequate public services have sometimes been lacking.

The State of Missouri has no authority or regulations that require counties to adopt land use control measures. There are no state-wide planning and zoning, building, electrical, plumbing, or minimum housing codes (021). In 1966, State Regional Planning Commissions were established to serve in an advisory capacity only to counties within their districts. The East-West Gateway Coordinating Council serves St. Louis and Jefferson Counties. Although the Council can, and has, conducted studies on water and sewer facilities, transportation, housing, land use and parks, plans can only be implemented by local authorities.

St. Louis County is the only county within the Lower Meramec River Basin study area that currently has county-wide planning programs, comprehensive zoning codes, and subdivision ordinances (021,025). Although Jefferson County used to have planning and zoning programs, they were discontinued due to lack of community support. As a result, certain areas within the Lower Meramec River Basin have a mixture of incompatible land uses (e.g. commercial and industrial development encroaching on residential areas)(021).

As indicated in Table 22, Arnold, Fenton, and Kirkwood have subdivision ordinances with design standards in effect. Fenton and Kirkwood have city zoning ordinances and comprehensive city plans, while Arnold has no city ordinance but is currently considering a city plan. Data for other communities within the study area was not available (025).


U.S. RT 40
TOWN AND COUNTRY
FRONTENAC
DES PERES
HUNTLEIGH
LADUE
BRENTWOOD
MAPLEWOOD
ROCK HILL
WARSON WOODS
MANCHESTER RD
CITY OF ST LOUIS
GLENDALE
WEBSTER GROVES
BALLWIN
MANCHESTER
MO RT 00
ELLISVILLE
KIRKWOOD
TWIN OAKS
VALLEY PARK
MERAMEC RIVER
PEERLESS PARK
INTERSTATE 44
CRESTWOOD
GRANTWOOD VILLAGE
LAKESHIRE
ST GEORGE
WILBER PARK
TIMES BEACH
EUREKA
ST LOUIS COUNTY
JEFFERSON COUNTY
ARNOLD
MO RT 30
MO RT MM
MO RT 21
MISSISSIPPI RIVER

Improvements to Existing Facilities

New Construction

FIGURE 17

MAJOR IMPROVEMENTS AND NEW CONSTRUCTION PLANNED FOR 1995 LOWER MERAMEC RIVER BASIN

Source: (077)

TABLE 22

MUNICIPAL SERVICES

County and City	Date of Profile	Type of Local Government	Comprehensive City Plan	City Zoning Ordinance	Subdivision Ordinance
Jefferson County					
Arnold	January 1973	Third Class City	Under Consideration	No	Yes
St. Louis County					
Fenton	June 1972	Mayor-Council	Underway	Yes	Yes
Kirkwood	November 1970	Commission	Completed 1/15/70	Yes	Yes

Source: (025)

The 201 Facilities Plan, as a part of the 208 Planning process, will have a considerable influence on growth patterns in the study area. Facility service areas and design capacities were based on land use projections conducted during 208 Planning activities. These projections, which were supplied to local governments for review and comment to assure compatibility with plans, predict conversions in land use by watershed. Conversions from undeveloped, urban, pasture, row crop, and forest uses to commercial, high and low density residential, industrial, and recreational uses are projected in 5-year increments between 1970 and the year 2000. Lands deemed unsuitable for development (floodplain lands and lands of greater than 16 percent slope) were omitted from the projections. Thus, by using these projections as a basis, the 201 Plan will promote growth in accordance with the 208 Plan by providing the sewerage facilities necessary for development only in areas specified by the 208 projections. Due to the manner in which the 208 projections were developed, only growth in suitable areas will be encouraged and the compatibility of this growth will be assured.

WATER RESOURCES

Surface Water Quality/Quantity

Mississippi River - The Mississippi River, at the St. Louis Gaging Station on the downstream side of the Eads Bridge, has a drainage area of approximately 701,000 square miles. The average flow for the period of record, (114 years), was 177,000 cfs. The minimun flow for this period was 18,000 cfs, (December 21-23, 1863), and the maximum was 1,019,000 cfs, (June 10-11, 1903), (043). A discharge-duration curve for the Mississippi River is shown in Figure 18. Although flooding has occurred in every month of the year, higher flows are more frequently related to a combination of snow melt and heavy spring rains (044). Lowest flows for any given year typically occur during December or January.

Lateral mixing of the Missouri and Mississippi Rivers does not occur directly at their confluence, but takes place gradually. It is generally agreed that lateral mixing is not always complete upstream from the Jefferson Barracks Bridge, (approximately River Mile 169). Water quality in the Mississippi River varies markedly, both in time and location. Table 23 shows how certain water quality parameters varied during a 1½ year period at a location just downstream from the Jefferson Barracks Bridge, (River Mile 169).

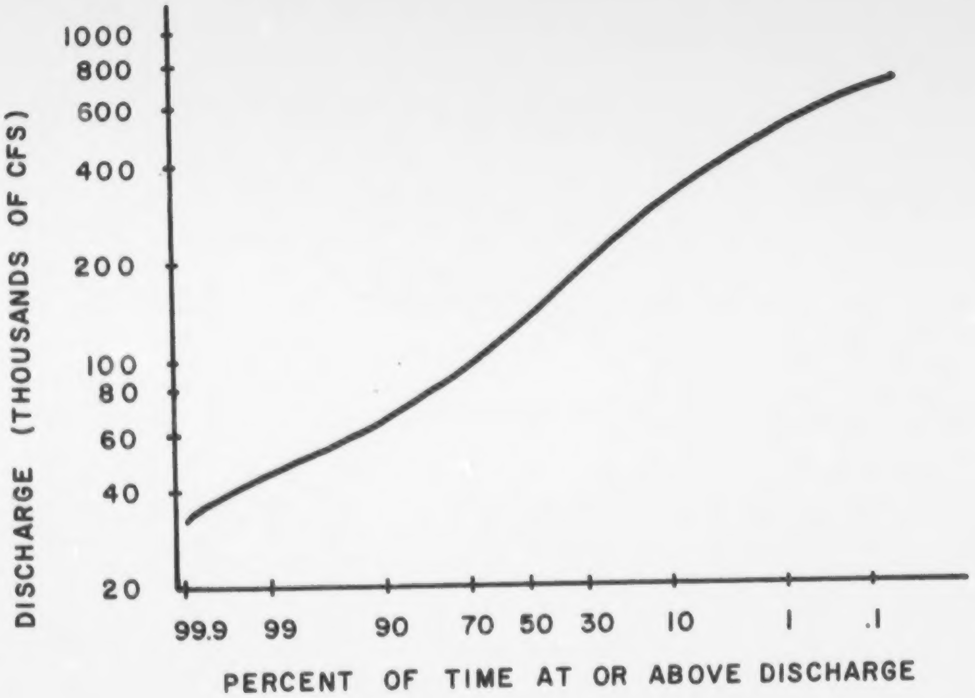


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FIGURE 18

DISCHARGE-DURATION CURVE AT
ST. LOUIS GAGE, MISSISSIPPI RIVER,
1955-1968

Source: (045)

TABLE 23

WATER QUALITY DATA, MISSISSIPPI RIVER (JEFFERSON BARRACKS BRIDGE)

	1973				1974											1975
	Aug.	Sep.	Oct.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Dec.	Jan.
Flow (cfs) x 1000	204	154	245	359	145	446	310	269	300	449	199	153	106	97	113	129
Air Temp (°C)	30	30	10	1	-4	10	1	10	12	27	39	20	28	21	3	7
Water Temp (°C)	28	23	15	8	0	3	4	7	15	23	32	25	22	16	4	5
pH	7.7	7.8	7.7	7.3	7.2	7.1	7.2	6.9	7.3	7.3	7.2	7.4	6.9	7.2	6.9	7.3
DO (mg/l)	6.0	7.3	8.5	9.8	14.7	11.3	11.1	11.3	8.7	6.1	5.6	6.5	8.4	8.3	11.8	12.0
Fecal Coliform (000/100 ml)	6.9	18	30	1	4.8	2.9	6.1	2	4.6	9.6	19.8	63	67	>6	11	>210
TDS (mg/l)	287	336	315	269	384	280	303	324	372	225	368	405	415	293	380	318
TSS (mg/l)	40	20	27	43	10	45	48	15	20	94	15	18	23	8	11	15
Total alkalinity (mg/l)	145	149	155	117	173	112	140	139	152	118	160	142	141	152	150	153
Nitrates (mg/l)	1.3	0.8	2.0	1.3	---	2.0	.95	1.03	1.55	2.0	1.85	.98	.30	.48	1.02	1.27
Total P (mg/l)	.42	.16	.42	0.00	.4	.11	.42	.21	.27	.84	.32	.65	.66	.22	.29	.28
Conductance (umhos/cm)	460	556	495	452	649	400	515	522	616	380	538	636	635	664	587	649
COD (mg/l)	22	14	12	18	13	22	21	12	12	41	15	16	21	12	9	13
BOD (mg/l)	1.6	2.9	2.8	3.2	5	3.8	4.2	2.8	---	3	4	8	8	6	5	6
NH_3-N (mg/l)	---	42	1.0	1.26	1.27	0.65	.72	0.58	.44	2.0	.27	.58	1.05	.90	.53	.88
O&G (mg/l)	---	3.0	3.3	0.7	2.5	1.7	7.3	4.0	6.8	8.0	83	7	35	104	---	<1
Chlorophyll (mg/l)	---	---	---	---	---	---	---	---	<05	---	.02	.04	.10	.03	.02	---

Source: (046) Performed by Corps of Engineers Water Quality Section

Meramec River - The drainage area of the Meramec River above where it enters the study area is approximately 3,840 square miles. The study area adds approximately 140 square miles of drainage area, for a total of 3,980 square miles. A brief frequency/discharge analysis of the Meramec River based on 8 years of data is summarized in Table 24. As indicated, the Meramec River's discharge is extremely variable, with a peak flow:low flow ratio of 162:1 (based on 55 years of record). This high ratio is due to the well integrated mature drainage network and low infiltration capacity for most of the drainage basin and is fairly typical of Ozark streams.

Although the peak flow:low flow ratio is very high, the base flow is relatively constant (see Table 25). Part of this low flow is augmented by the discharge of effluent from several wastewater treatment plants (see Table 26), whose combined discharges account for roughly 12 percent of the 7 day/10 year low flow of the Meramec River. Peak withdrawals usually occur during low flow periods, and sometimes exceed 40 cfs. Most of this water is withdrawn at a point near Fenton, MO (047), by the St. Louis County Water Company at their South County Plant.

The 1944 and 1973 river bed profiles for the lower 35 miles of river are shown in Figure 19. As indicated, the general trend for the lower 30 miles of river has been a decrease in elevation over the last 30 years. Although this phenomenon appears to conflict with the popular opinion that the Lower Meramec River bottom is accumulating sediment due to man's activity in the upper Meramec, much of the present variation and general decrease in elevation is attributable to sand and gravel mining operations.

As evidenced by Figure 19, the gradient in the lower reaches of the river is extremely flat. The water surface of the river's lower reaches is controlled by the Mississippi River's stage, and effects of backwater from the Mississippi on the Meramec are evident throughout the study area.

The combination of the Meramec's variable flow and "backwater flooding" from the Mississippi has resulted in the creation of considerable "wetland" acreage in the study area. The significance and extent of this acreage is discussed under "Biological Resources" (and is illustrated in Figure 28).

The water quality/quantity data for creeks tributary to the Meramec River is extremely limited, but data that are available indicates that many of the study area's creeks stop flowing during prolonged periods of dry weather. Wastewater treatment plant effluent constitutes a major portion of the flow of those creeks that do flow continuously.

TABLE 24

FREQUENCY/DISCHARGE ANALYSIS MERAMEC RIVER 1967-1974[(a)]

Water Year	Average Discharge (cfs)	Flow Exceeded (percent)			
		10,000 cfs	3,043 cfs	2,000 cfs	1,000 cfs
1974	4,788	11	46	59	80
1973	5,237	13	48	67	81
1972	2,369	5	13	20	43
1971	1,968	1	13	33	77
1970	3,010	5	26	41	73
1969	4,104	6	40	57	80
1968	3,628	8	27	37	71
1967	2,142	2	18	29	55
8-Year Average	3,406	6.4	29	43	70

NOTES: (a) Average discharge of Meramec River near Eureka, MO is 3,043 cfs based on 55 years of data.

Source: (048)

TABLE 25

LOW FLOW FREQUENCY DATA
MERAMEC RIVER NEAR EUREKA, MO(a)

Recurrence Interval (years)	Annual Low Flow (cfs)				
Period (Days)	2	5	10	20	50
7	420	310	280	230	190
14	450	330	300	250	215
30	500	360	320	290	230
60	590	405	350	340	260
90	680	480	410	380	290

NOTES: (a) Record Used in Analysis: 1922-1969
Drainage Area: 3,788 Square Miles

Source: (009)

TABLE 26

WASTEWATER FLOW FOR WATERSHEDS - 1970

Watershed	Average Wastewater Flow (MGD)
Fishpot	1.562
Grand Glaize	3.370
Meramec Sub-area #6	.149
Yarnell	.344
Fenton	.531
Meramec Sub-area #7	.248
Meramec Sub-area #12	.099
Saline Creek	.496
Watershed Area #10	.065
Mattese	1.853
Big Muddy	.250
Little Muddy	.372
Pomme	.156
Total Flow to Tributaries	9.495
Direct Flow to Meramec River	11.248
Total Wastewater Flow	20.743

Source: (049)

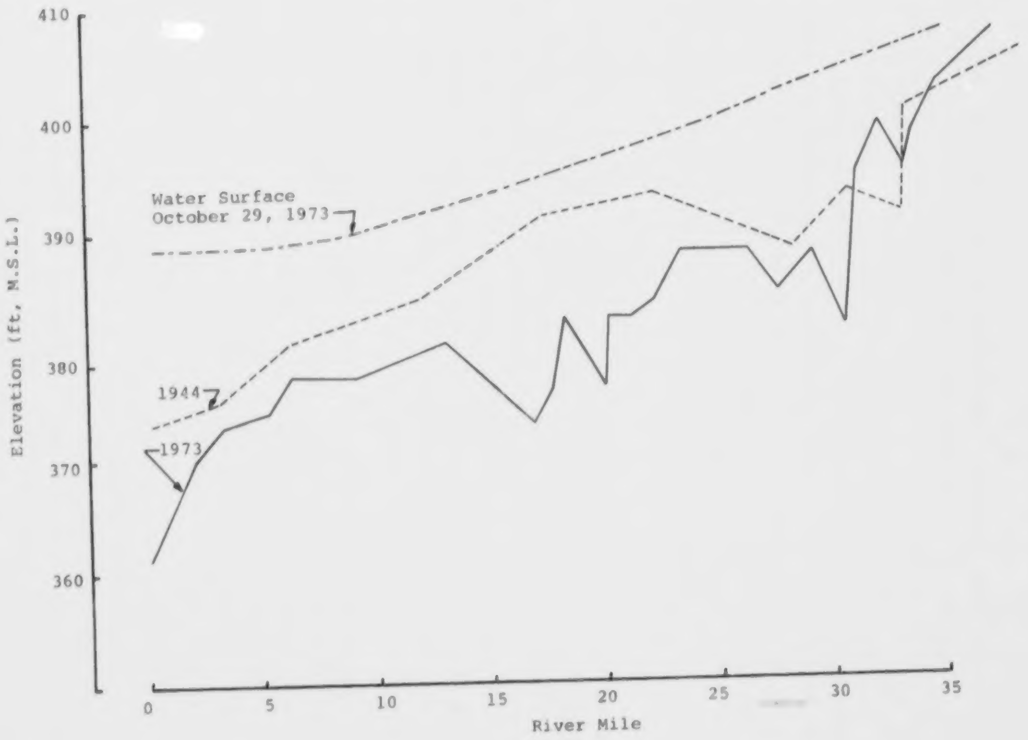

FIGURE 19

MERAMEC RIVER BED PROFILES
1944 AND 1973

Source: (050)

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Based on the average rate of runoff for the Meramec River Basin (10.91 in/yr), the average natural contribution of the study area to the average flow of the Meramec River is 115 cfs. Most of this flow occurs during and shortly after periods of rainfall and, therefore, natural additions to the base flow of the Meramec River from the study area are probably quite small.

Major floods have occurred throughout the year in the St. Louis area, but are most common in spring and summer. Severe flooding in the area is due to intense thunderstorms or backflooding from the Mississippi River. Intense flooding can cause nearly flash flood conditions on the Meramec River, where the discharge of the river can increase from less than 1,000 cfs to more than 30,000 cfs within a 24- to 48-hour period. The most severe flooding due to the Mississippi River backflooding is usually associated with heavy spring rains occurring during the snowmelt period in the upper Mississippi River drainage basin. A flood-frequency curve for the Meramec River showing elevation near Eureka is shown in Figure 20.

Whereas the Meramec River's water quality is generally good, the water quality of many of the tributaries is generally poor (see Table 27). A major reason for this is the high base flow of the Meramec River, which is sustained by springs and seeps in the upper reaches. Even during prolonged periods of low flow during hot weather (worst case conditions), the dissolved oxygen level at the U. S. Geological Survey monitoring station at Paulina Hills rarely drops below 5 mg/l (049).

In 1968, the Federal Water Pollution Control Administration set two levels for ammonia-N in surface waters: a "desirable" level (0.01 mg/l), and a "permissive" level (0.5 mg/l) not to be exceeded for surface water which was to be used as a public water supply source. As indicated in Table 28, the Meramec River's ammonia concentrations have frequently exceeded the desirable limit but have never exceeded the permissive level. During the sampling program from which the data in Table 28 was taken, two sets of samples starting at river mile 2.5 and continuing downstream to the mouth showed ammonia nitrogen concentrations of 0.21 to 0.56 mg/l, atypically high values for which no satisfactory explanation has been given. With the exception of these values, ammonia nitrogen concentrations for the same reach during the same sampling programs averaged 0.13 mg/l, and never exceeded 0.19 mg/l (049). The high ammonia nitrogen concentrations in most of the study area's tributary streams are probably due to wastewater treatment plant discharges since several of these discharges have been sampled at different times and have had ammonia nitrogen concentrations of 20 mg/l to 40 mg/l, with some exceeding 80 mg/l (047,049).

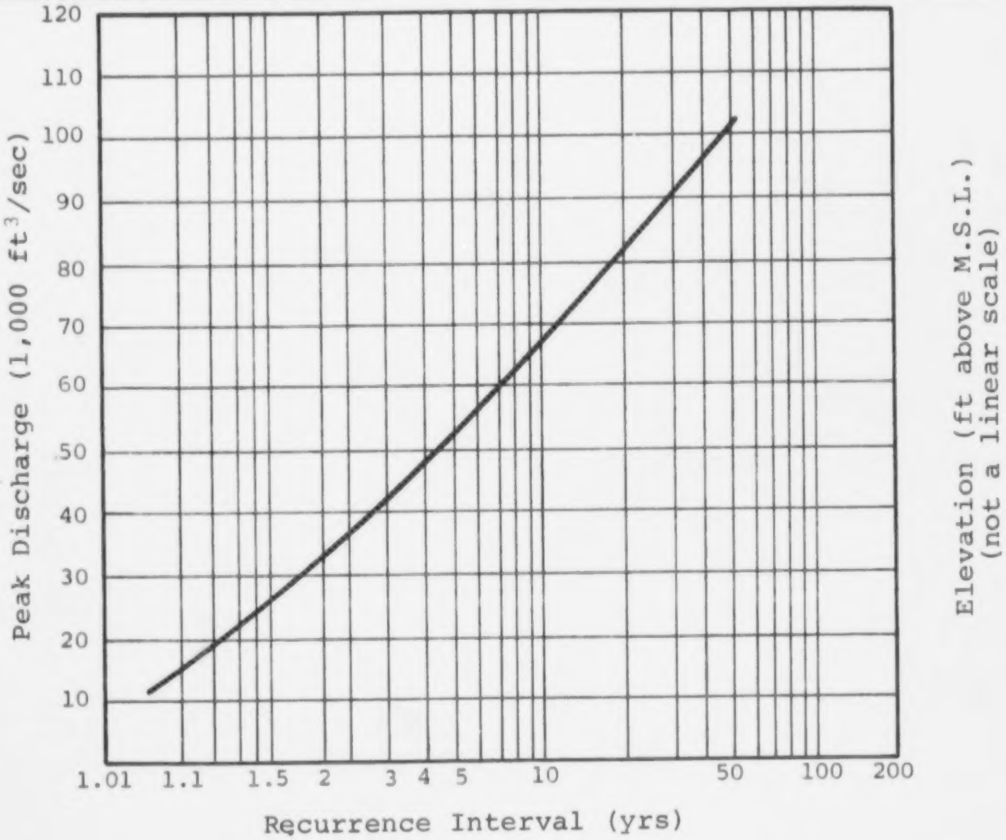

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FIGURE 20

FLOOD-FREQUENCY CURVE FOR
MERAMEC RIVER NEAR EUREKA, MO

Source: (009)

TABLE 27

WATER QUALITY MERAMEC RIVER AND TRIBUTARIES[a]

River/ Creek	Drainage Area (acres)	BOD_5		NH_3-N		Total Phosphorus		Total Solids	
		Low Flow (mg/1)	High Flow (mg/1)	Low Flow (mg/1)	High Flow (mg/1)	Low Flow (mg/1)	High Flow (mg/1)	Low Flow (mg/1)	High Flow (mg/1)
Meramec River at Paulina Hills	172 Million	3	32	.02	.06	.18	.40	265	230
Fishpot Creek	6,696	8.3	7.7	13.0	7.5	12.0	7.3	550	N/A
Grand Glaize Creek	15,161	17.0	44.0	0.79	2.70	1.81	2.30	1,500	N/A
Yarnell Creek	1,845	6.9	13.0	1.05	1.22	5.00	3.70	525	N/A
Fenton Creek	3,673	24.0	10.0	11.0	0.69	9.6	1.15	500	N/A
Saline Creek, (including Sugar and Romaine Creeks)	12,821	2.7	4.1	0.09	0.26	0.20	0.58	N/A	N/A
Mattese Creek	8,534	35.0	33.0	11.0	4.3	8.3	3.8	N/A	N/A
Pomme Creek	4,974	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Williams Creek	6,311	1.9	10.8	1.6	0.40	N/A	1.20	375	N/A
Kiefer Creek	4,580	1.60	0.60	0.01	0.02	.14	.10	2,340	N/A

TABLE 27

WATER QUALITY MERAMEC RIVER AND TRIBUTARIES
(Continued)

River/Creek	Fecal Coliform		Number of Major Wastewater Discharges (Industrial and Sanitary)	Average Wastewater Flow (cfs)
	Low Flow (colonies/100ml)	High Flow (colonies/100 ml)		
Meramec River at Paulina Hills	15	3,800	22	N/A
Fishpot Creek	600	13,000	1	2.46
Grand Glaize Creek	1	100	4	4.26
Yarnell Creek	1,000	160,000	1+(b)	0.45
Fenton Creek	1,600	5,400	2	0.51
Saline Creek (including Sugar and Romaine Creeks)	300	300	3+	0.73
Mattese Creek	>400,000	160,000	3+	2.39
Pomme Creek	N/A	N/A	+	N/A
Williams Creek	4,900	N/A	N/A	N/A
Keifer Creek	230	N/A	N/A	N/A

NOTES: (a) N/A = Not available
(b) Several minor discharges

Source: (047, 048, 049)

TABLE 28

AMMONIA NITROGEN CONCENTRATIONS

River/Creek	Percent of Measurements Exceeding						
	5.0 mg/l	1.0 mg/l	0.5 mg/l	0.20 mg/l	0.10 mg/l	0.02 mg/l	0.01 mg/l
Meramec River at Paulina Hills(a)	0	0	0	1	14	57	70
Fishpot Creek(b)(c)	88	100	100	100	100	100	100
Grand Glaize Creek(b) (c)	0	61	100	100	100	100	100
Yarnell Creek (b)(c)	0	28	33	78	94	100	100
Fenton Creek(b)(c)	35	94	100	100	100	100	100
Saline Creek(b)	0	0	0	30	90	100	100
Mattese Creek(b)	89	100	100	100	100	100	100
Kiefer Creek(c)	0	13	13	38	50	88	88

NOTES: (a) 83 measurements at Paulina Hills since November 1967
(b) 10 consecutive days starting October 30, 1973
(c) 6 to 10 measurements made during August 1971

Source: (047, 048, 049)

Whereas chemical oxygen demand (COD) values in excess of 30 mg/l are uncommon for the Meramec River (047,048,049). COD values for many of the tributaries are frequently in excess of 40 mg/l (047). Biological oxygen demand values are also frequently in excess of 20 mg/l in many of the tributaries (049) (see Table 27). Because of the generally high aeration rate of the Meramec River even at low flow, the infrequently high BOD and COD values do not represent a serious problem in the Meramec River. However, the high values in the tributaries are cause for concern.

Groundwater Quality/Quantity

Occurrence of Groundwater - The amount of water stored below ground in Missouri far exceeds the total amount of surface water in the state. This enormous reservoir sustains stream flow during precipitation-free periods and is a significant source of fresh water for many localities. This water occurs in fractures and solutional conduits in the limestones, and in the interstices or void spaces between sediment particles in clastic sedimentary rocks and unconsolidated sediments.

The aquifers in the study area fall into two groups, bedrock and alluvial. The alluvial aquifers are restricted to the Bottomland topographic region described earlier. Not all of the alluvium in the study area is capable of transmitting large quantities of water. Much of the alluvium is composed of fine grained sediments (silts and clays) and acts as a local confining bed. The coarser grained alluvial deposits (sands and gravels) act as excellent aquifers, as evidenced by the well field at Valley Park. Well data for four of these wells are summarized in Table 29.

The Meramec River Bottomland Region (see Figure 10) contains the alluvial aquifers capable of producing the highest yields. Cross-sections through the Meramec River alluvium indicating its vertical heterogeneity are shown in Figure 8.

There are two types of bedrock aquifers in the study area, sandstone and limestone/dolomite. The best example of a sandstone aquifer is the St. Peter Sandstone which is composed of pure, well sorted quartz sand grains, loosely cemented together. It is an excellent aquifer and wells developed in this unit consistently yield more than 100 gallons per minute (gpm).

Limestone and dolomite aquifers generally have little or no primary porosity or permeability. Most of the water occurring in these rocks is found in fractures enlarged by solution. The solutional enlargements can exceed 10 feet in diameter (051). Solutional activity is frequently concentrated at the water table zone (047); however, large conduits have formed and are continuing to form well below this zone (051). Due to this occurrence, yields from wells can vary tremendously (e.g. 10 gpm to as much as 400 gpm for the same aquifer group) (009).

TABLE 29

SUMMARY OF WELL DATA FOR THE VALLEY PARK ALLUVIAL AQUIFER[a]

Owner	Depth (ft)	Well Diameter (in)	Date of Test	Pumping Rate (gpm)	Duration of Test (hrs)	Specific Capacity (gpm/ft of drawdown)	Drawdown (ft)
Valley Park	63	18	August 1949	504	24	72	7
Valley Park	63	18	July 1949	504	24	36	14
Absorbent Cotton	63	16	May 1957	500	12	83	6
Absorbent Cotton	59	16	October 1959/ June 1964	503 554	-- --	102 111	5 5

NOTE: [a] See Figure 21 for location of wells

Source: (009)

Groundwater Movement - Water in an aquifer occurs under either artesian conditions (confined aquifer) or water table conditions (unconfined aquifer). Since most of the bedrock aquifers and some of the alluvial aquifers are confined, generally by an aquiclude, at both their upper and lower surfaces, the aquifers are frequently not freely hydraulically connected and the direction of groundwater movement can vary considerably with depth. Therefore, only a very generalized description of groundwater movement can be given.

Most groundwater movement in the study area is nearly horizontal, especially in the bedrock aquifers. Near pumping wells, movement is radially inward toward the well. The alluvial aquifer near the Valley Park well field (see Figure 21) is an example of this type of groundwater movement. In alluvial aquifers, groundwater movement is typically toward the associated river or stream. This direction, however, can be reversed during flooding or periods of sustained high river stages, and by high-capacity wells pumping close enough to the river to induce recharge (e.g. the Valley Park well field) (009). Many of the alluvial aquifers along the Meramic River are water table aquifers. The groundwater movement of this type of aquifer is generally toward tne nearest discharge point, such as a river or pumping well.

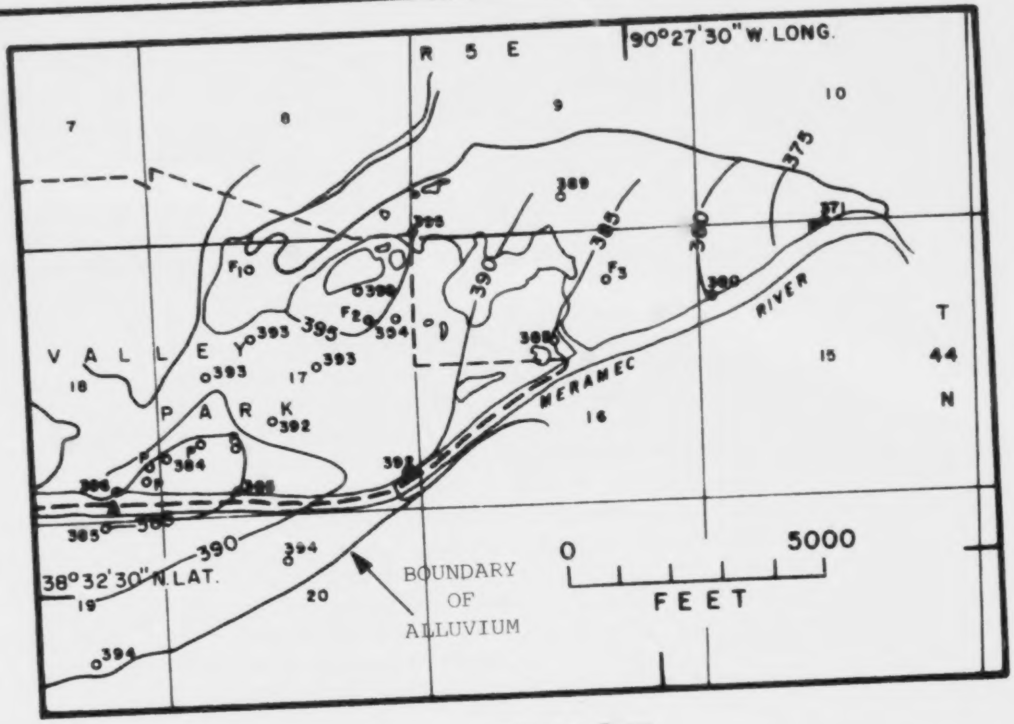
Groundwater Recharge - The bedrock aquifers are recharged from precipitation falling directly on the exposed rock, the overlying soil, and adjacent aquifers.

Recharge in the bedrock outcrop area is minimal. Most of the precipitation that falls in the area becomes runoff. The bedrock outcrop areas are concentrated in the Hilly Uplands topographic region (see Figure 10). Shallow bedrock aquifers that are hydraulically connected to the river and creeks also receive recharge from natural infiltration of the rivers and creeks during sustained high river stage and flooding (009).

The alluvial aquifers shown in Figure 10 are recharged directly from precipitation, infiltration from the river and creeks during high river stages and flooding, and by underflow from adjacent bedrock units.

Based on estimates of recharge given in Water Resources (009), the alluvial aquifers in the study area are capable of yielding several million gallons of water per day, even without artificially inducing recharge from the river and creeks.

Groundwater Discharge - Natural discharge from aquifers in the study area occurs through four primary processes: 1) seepage from the alluvium into streams and creeks; 2) transpiration through plants; 3) discharges through wells; and 4) direct evaporation. Seepage accounts for most of the streams' and creeks' base flows, while seepage and transpiration account for a large portion of the total groundwater discharge.


90°27'30" W. LONG.
R 5 E
7
8
9
10
375
389
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371
F10
0390
F2
394
390
F3
380
395
393
393
17 393
VALLEY
PARK
18
392
15
T 44 N
MERAMEC RIVER
16
384
392
386
385
385
390
394
38°32'30" N. LAT.
19
20
394
BOUNDARY OF ALLUVIUM
0 5000 FEET

386

Observation well and altitude of potentiometric surface, in feet above mean sea level.

F_1

Deep well in bedrock that flows at ground surface.

P

Pumping well

390

Contour shows altitude of potentiometric surface, July 1970, in the alluvial aquifer.

Stream Gage

Elevation of river's water surface at stream gage when water level in wells measured was 391 feet. Since direction of groundwater movement is from areas of high potential to low potential, at the time data for this map was collected, water was moving toward pumping wells from surrounding alluvial aquifer, from Meramec River, and from bedrock beneath alluvium.

RETA

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FIGURE 21

POTENTIOMETRIC SURFACE - ALLUVIAL AQUIFER - VALLEY PARK AREA

Source: (009)

Discharge caused by direct evaporation from the groundwater reservoir is probably negligible in the study area. This is also true for the springs in the study area since most of them are quite small and many flow only during and shortly after heavy rains (009). No quantitative estimates on discharges in the study area are available at the present time.

Groundwater Quality - The shallow aquifers in northern Jefferson County and most of the alluvial aquifers generally yield good quality water to wells. This water is typically a calcium-magnesium-bicarbonate type. The alluvial aquifer in the Valley Park area, however, does contain as increasing amount of saline water (chloride concentrations in excess of 250 mg/l) (see Figure 22). The suspected source of this sodium-chloride type water is the deep bedrock aquifers leaking upward through improperly constructed or cased deep wells, and natural seepage. In addition to the high concentrations of sodium and chloride ions, the water also contains significant quantities of iron and manganese.

In addition to the above-mentioned salinity problem, a few localized instances of high nitrate concentrations occur in the alluvial aquifers. The source of this type of contamination is usually leakage in septic tanks or improperly located or designed leach fields.

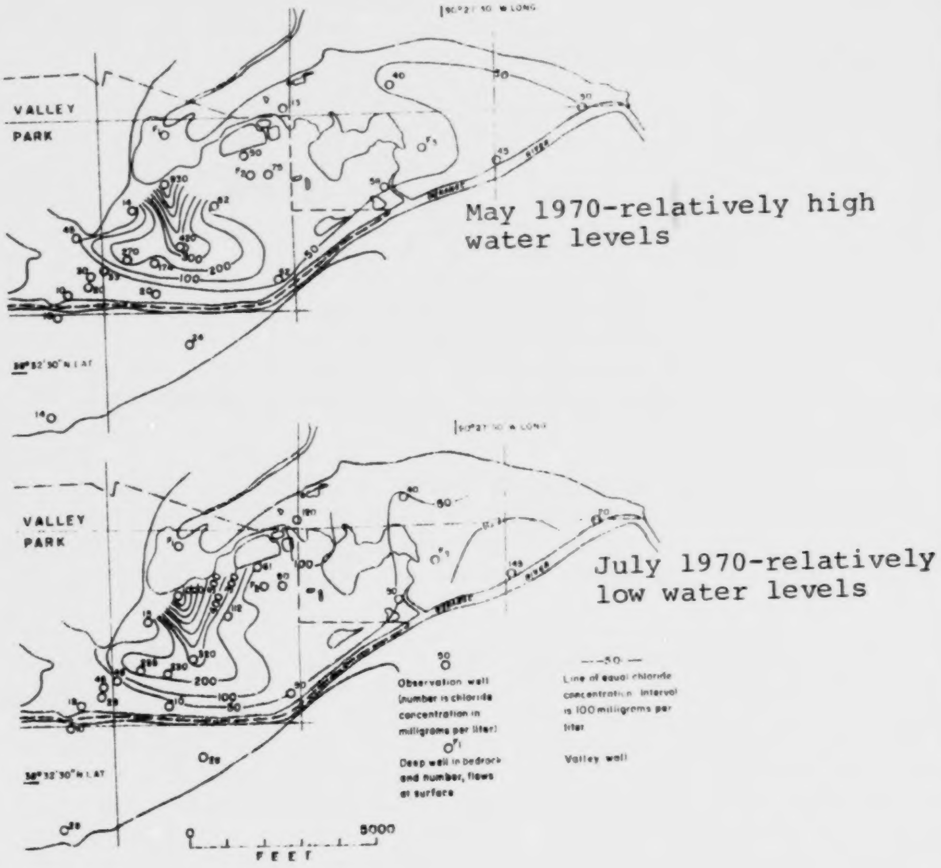
All of the deep bedrock aquifers (Cambrian and Ordovician systems) and portions of the shallow bedrock aquifers (Mississippian and Pennsylvanian systems) contain highly mineralized water. It is suspected that this is connate water (009). Chloride concentrations in excess of 250 mg/l are typical, and concentrations in excess of 4,000 mg/l have been reported (see Figure 23). The area of high chloride concentration shown in Figure 23 is centered on a structural depression (052) and the cause of this localized concentration of highly mineralized water is suspected to be the natural upward migration of the deeper, saline water (009).

In addition to high concentrations of sodium and chloride ions, iron concentrations also frequently exceed 0.3 mg/l, and have exceeded 10 mg/l (009) (see Figure 24). Available water quality data from wells in the study area is summarized in Table 30. The location of these wells is shown in Figure 25.

Water Usage

Water usage can be divided into two categories: consumptive uses which include irrigation, livestock watering, drinking water supplies, and some industrial process and cooling water; and non-consumptive uses which include fishing, boating, swimming, receipt of effluents, navigation, and once-through industrial cooling. Municipal water supply usage can sometimes fall

WATER RESOURCES OF THE ST LOUIS AREA, MISSOURI


90°27'30" W LONG
VALLEY
PARK
38°32'30" N LAT
RIVER
VALLEY
PARK
200
100
50
0
5000
FEET
Observation well (number is chloride concentration in milligrams per liter)
Deep well in bedrock and number, flows at surface
---50---
Line of equal chloride concentration. Interval is 100 milligrams per liter
Valley wall

May 1970-relatively high water levels

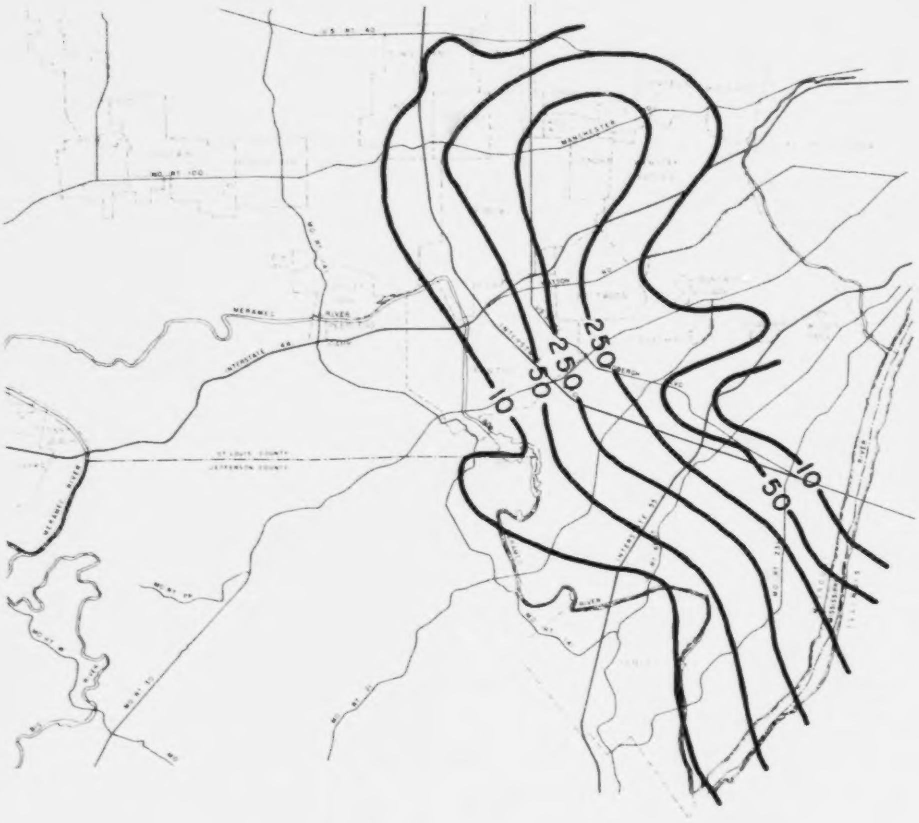
July 1970-relatively low water levels

RETA

RR06

FIGURE 22

DISTRIBUTION OF CHLORIDE IN ALLUVIAL DEPOSITS IN THE VALLEY PARK-KIRKWOOD AREA


U.S. RT. 40
MO. RT. 100
MANCHESTER
MO. RT. 141
MERAMEC RIVER
INTERSTATE 44
ST. LOUIS COUNTY
JEFFERSON COUNTY
MERAMEC RIVER
MO. RT. 30
MO. RT. 21
INTERSTATE 55
MO. RT. 21
MISSISSIPPI RIVER
250
250
50
10
10
50

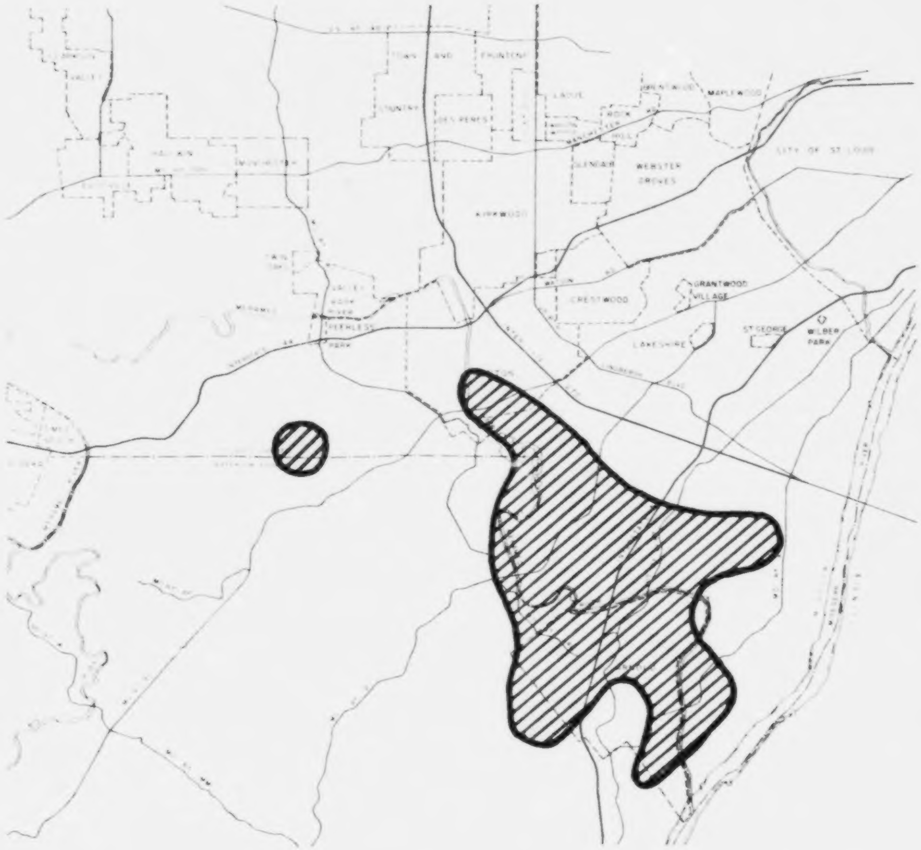
NOTE: Concentrations in mg/l

RETA

FIGURE 23

DISTRIBUTION OF CHLORIDE ION CONCENTRATIONS IN MISSISSIPPIAN AND PENNSYLVANIAN AQUIFERS

Source: (009)


TOWN AND COUNTRY
FRONTENAC
DES PERES
LADUE
BRENTWOOD
MAPLEWOOD
ROCK HILL
CITY OF ST LOUIS
GLENDALE
WEBSTER GROVES
KIRKWOOD
BALLWIN
MANCHESTER
TWIN OAKS
VALLEY PARK
MERAMEC
PEERLESS PARK
CRESTWOOD
GRANTWOOD VILLAGE
LAKESHIRE
ST GEORGE
WILBER PARK

▨ Indicates an area where iron concentrations in groundwater from bedrock aquifers is in excess of 0.3 mg/l

RETA

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FIGURE 24

DISTRIBUTION OF
HIGH IRON CONCENTRATIONS

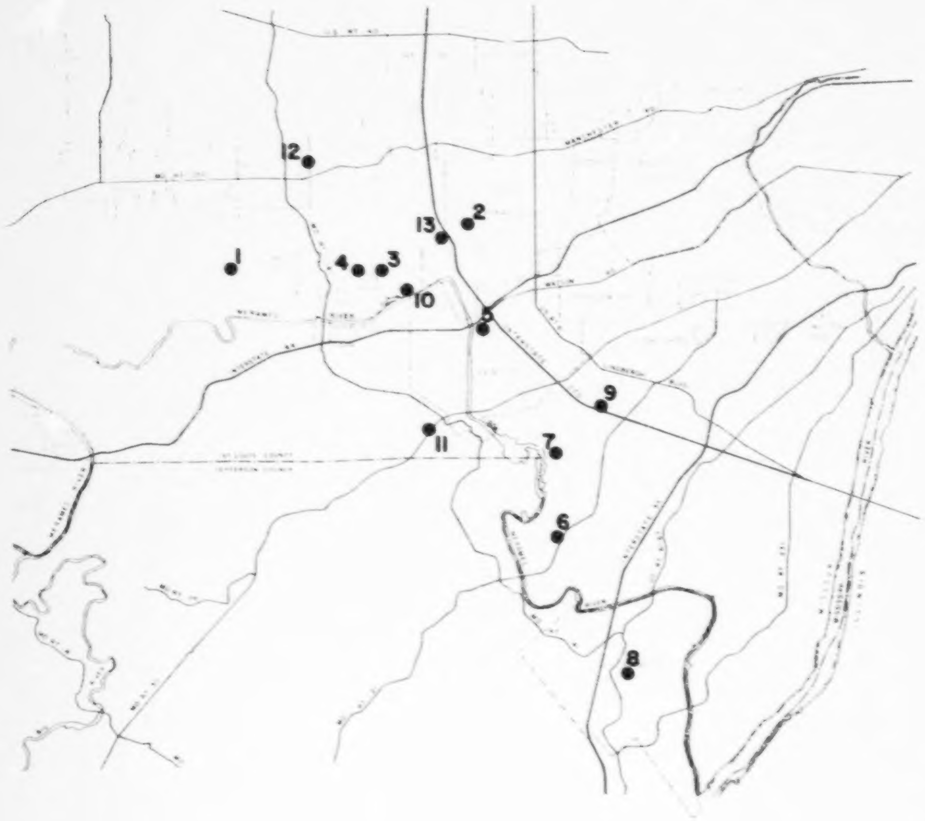
TABLE 30

SUMMARY OF AVAILABLE WATER QUALITY DATA FROM WELLS IN THE STUDY AREA[(a)(b)]

Aquifer →	Alluvial							Shallow Bedrock		Deep Bedrock			
Well Number →	1	2	3	4	5	6	7	8	9	10	11	12	13
Depth (ft)	42	53	63	62	58	48	43	301	409	365	800	798	1345
Date of collection	6/68	6/68	8/69	8/69	6/68	6/68	6/68	12/60	6/41	4/41	5/62	2/37	6/34
Temperature (°C)	13	14	14	13.5	15	-	12	-	-	-	-	-	-
Silica (SiO_2)	11	8.9	12	13	10	9.2	9.1	4.8	12	5.6	8.0	8.8	8.0
Iron (Fe)	0.11	0.70	0.34	0.00	3.6	3.4	0.10	0.23	-	-	0.04	0.15	0.20
Manganese (Mn)	0.00	1.3	0.61	0.33	1.2	0.80	0.00	-	-	-	-	-	-
Calcium (Ca)	60	56	87	57	98	51	36	81	262	74	46	325	464
Magnesium (Mg)	18	15	26	16	33	14	15	45	131	26	25	149	187
Sodium (Na)	28	42	140	26	9.4	25	7.7	11	1310	28	9.8	1810	2570
Potassium (K)	1.8	3.4	4.6	2.2	1.4	1.8	0.9	-	-	-	-	-	-
Bicarbonate (HCO_3)	212	185	158	158	403	212	132	466	339	339	252	267	250
Carbonate (CO_3)	0	0	0	0	0	0	0	0	0	0	0	-	8
Sulfate (SO_4)	39	72	108	88	62	32	34	11	262	49	19	442	563
Chloride (Cl)	47	54	277	32	8.4	24	18	4.0	2360	14	12	3320	4370
Fluoride (F)	0.1	0.1	0.1	0.0	0.3	0.0	0.1	0.3	-	-	0.7	-	2.8
Nitrate (NO_3)	9.3	0.0	0.0	4.2	0.5	0.3	4.8	0.0	-	-	0.1	0	0.1
Dissolved solids(180°C)	337	351	742	331	438	283	201	404	5050	424	270	7270	4650
Hardness (Calcium (Magnesium	224	201	324	208	380	185	152	387	1190	290	216	1420	1930
(Noncarbonate	50	50	195	78	50	11	44	4	913	12	12	-	-
Specific conductance (Micromhos at 25°C)	569	593	1290	536	747	467	391	-	-	-	-	-	-
pH	7.4	7.4	7.6	7.5	7.7	7.4	7.3	-	-	-	-	-	-

NOTES: [(a)] See Figure 25 for approximate locations
[(b)] In mg/l except where indicated

Source: (009)



12
2
13
1
4
3
10
5
9
11
7
6
8

● 9 Well and Well Number (see Table 30)

RETA

FIGURE 25

LOCATION OF WELLS

Source: (009)

under both categories, since municipal wastewater flows can provide up to 100 percent[1] of the water supplied (047, 053). Another type of water consumption, especially in the tributaries, is recharge to the groundwater system. Portions of many of the tributaries have been classified as "losing" or influent streams.

Consumptive Uses - No estimates are currently available concerning the amount of Meramec River water consumed for agricultural purposes or the amount of water that seeps into the ground from the tributaries. The amount of water used for industrial purposes, including once-through cooling water, is estimated to average between 20 and 35 cfs for the study area (049). Estimates of water withdrawn for municipal water supplies are given in Table 31.

Non-Consumptive Uses - Sand and gravel mining operations in and along the Meramec River are probably the major industrial nonconsumptive users of water. One mining procedure which requires water involves using a hydraulic dredge and screen system to return excess water to the river. The amount of sand and gravel mined in the study area is about 1,125,000 tons/yr (054). Estimates of the amount of water used in the method described above are not available.

The Meramec River receives a significant amount of municipal and industrial wastewater effluents. It is estimated that the river receives an average of 21 MGD of effluent from different sources. Although there have been occasional taste and odor problems with the drinking water (055), most of which are caused by high ammonia, nitrogen and phenol concentrations, this problem has occurred less frequently in recent years. Small amounts of oil and petroleum products are added to the river because the river is used for power boating and navigational purposes. As the area's population increases, the use of the river for these purposes will also increase.

Water Quality Management

Past Planning Efforts - Prior to World War II, the only type of water quality management planning for the Meramec River was done by the U. S. Army Corps of Engineers, whose main concern was navigation and flood control.

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[1] High return flows can be caused by infiltration into the sewer system due to rainfall and/or high groundwater table.

TABLE 31
WATER CONSUMPTION

	Sources of Water								
	Meramec River (cfs)			Meramec River Alluvium (cfs)			Total (cfs)		
Major Consumer	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.
City of Kirkwood	4.7	2.7	9.3	1.5	1.5	1.5	6.2	4.2	10.8
St. Louis County Water Company	46.4	27.8	61.9	-	-	-	46.4	27.8	61.9
Valley Park	-	-	-	0.8	0.5	1.2	0.8	0.5	1.2
Total	51.0	30.5	71.2	2.3	2.0	2.7	53.4	32.5	73.9

Source: (055, 056, 057)

The City of Kirkwood was the first municipality in the study area to recognize the need for a "full, coordinated sanitary sewer system" (047). This city constructed a sewage treatment plant on the Sugar Creek branch of Grand Glaize Creek in 1952 to serve areas within Kirkwood's corporate boundaries lying within the Meramec River drainage basin. In 1954, the Metropolitan St. Louis Sewer District was formed, and the above facility was incorporated into the MSD system (004).

In 1957, several leaders of the smaller communities in the study area held a series of discussions concerning the need for an area-wide sewage treatment system. These discussions failed to bring about any positive actions, and in 1958 the City of Ellisville initiated a program to provide sanitary sewer service for its residents (047).

Under the Missouri Revised Statutes of 1959, the newly formed Missouri Water Pollution Board was empowered to "administer and request enforcement of the laws of the state relating to the prevention and control of pollution", and to "establish or revise standards of water purity for any of the waters of the state" (047). The Board published water quality standards for the Meramec River Basin in June, 1968. These standards were based on the results of a comprehensive stream survey program authorized by the Governor in 1962, and performed by personnel from the Missouri Water Pollution Board, the Missouri Department of Conservation, the U. S. Geological Survey, and other state and federal agencies. (004).

The East-West Gateway Coordinating Council was formed on December 8, 1965 under the name of St. Louis Area Council of Local Governments. Its primary purposes were: 1) to conduct a series of studies relating to problems affecting the overall region; 2) to act as the agency through which the individual local governments could coordinate their efforts at solving mutual problems; and 3) to act as review agency for federal funds applications for programs proposed by local planning agencies in the St. Louis area. The EPA has designated the East-West Gateway Coordinating Council as the agency responsible for conducting planning efforts under Section 208 of PL 92-500.

From October 18, 1972 (date PI 92-500 was passed) to October 30, 1974, the EPA was responsible for issuing National Pollutant Discharge Elimination System (NPDES) permits, the purpose of which were to achieve water quality standards (authorized under PL 92-500 and published in 1973). As of October 30, 1974, the issuance of NPDES permits has been the responsibility of the Water Quality Program of the Division of Environmental Quality, Missouri Department of Natural Resources (058).

Under the water quality standards, the Meramec River in the study area is classified as a "Class A" stream, which means it is suitable for whole-body contact recreation. A "Class A" stream must meet the following criteria (058):

pH:	6.5 to 8.5
Dissolved oxygen:	$\geqq 5$ mg/l
Fecal coliform:	$\leqq 200$ MPN per 100 ml - geometric mean
	$\leqq 400$ MPN per 100 ml - at least 90 percent of the total samples
Temperature increase due to effluents:	$\leqq 5$°F (2.8°C)
Maximum temperature due to effluents:	$\leqq 90$°F (32.2°C)

The stream must also be free of grease and oil and of substances which are potentially toxic or detrimental; cause turbitity; impart color; and produce taste or odor.

Fishpot and Grand Glaize Creeks are designated as "protected streams" due to their "losing stream" or "influent stream" character. The water quality standards for protected streams permit no discharges other than uncontaminated cooling water to help prevent contamination of the groundwater (058). The Meramec River, below Times Beach,is designated as a "water quality limited" segment, which means it is expected to have continued water quality problems even after each discharge reaches the 1977 minimum required wastewater treatment levels (049). Since load allocations are required for water quality limited segments of streams, the Missouri Clean Water Commission contracted a consultant to conduct a load allocation study of the Lower Meramec River Basin. This study was completed in October,1974 (049).

The severe water pollution problems of Fishpot and Grand Glaize Creeks prompted the EPA to award a water quality management planning assistance grant in December,1970. Results of this study were published in "St. Louis County Water Pollution Control Study - Phase 1" (047).

In May 1971, construction of sewage treatment facilities in the City of Arnold was halted by the Missouri Water Pollution Board (Missouri Clean Water Commission), pending the development of a watershed plan for the handling and treatment of sanitary sewage. Following this action, Horner and Shifrin, Inc. was contracted by the City of Arnold to prepare a "Study of Interceptor Sewers, Truck Sewers, and Wastewater Treatment Facilities" (023).

Present and Future Planning Efforts - There are currently three major water quality management planning efforts underway in the study area. The East-West Gateway Coordinating Council is conducting studies under Section 208 of PL 92-500. MSD is developing a coordinated plan for the collection, transportation, and treatment of municipal wastewater for the study area within Section 201 of PL 92-500. In order to receive federal funds for implementation of this plan, the Coordinating Council will have to approve the plan. The Water Quality Program of the Division of Environmental Quality, Missouri Department of Natural Resources, has recently completed a draft of the "Water Quality Management Basin Plan for the Upper Mississippi - Meramec River Basin", June, 1976, in accordance with Section 303 (e) of PL 92-500 (058).

Under PL 92-500, the states are charged with the responsibility of maintaining a continuing planning process, in order to meet the "national goal that the discharge of pollutants into the navigable waters be eliminated by 1985" (059).

Existing Facilities and Problems - There are seven publicly owned treatment facilities, 22 industrial and mining discharges, and 168 privately owned treatment facilities in the study area (058). Over 50 of these sources are major discharges. Discharges range from uncontaminated cooling water to poorly treated sanitary sewage. Almost all of the discharges have received some form of secondary treatment. However, high concentrations of ammonia and BOD5 are typical of many of them (049, 058).

Phenol concentrations and stormwater discharge are two additional areas of concern. Phenol concentrations in the Meramec River have often exceeded 1.0 μg/l, the preferable limit for drinking water. Phenol cannot be removed by conventional water treatment and, when combined with the chlorine necessary for bacterial control, creates an objectionable odor and taste (058). Urban stormwater discharge has caused higher than average concentrations of organic nitrogen, ammonia nitrogen, and total phosphorus in the Meramec River and its tributaries. This problem is currently being studied by the East-West Gateway Coordinating Council as part of its 208 Study (058).

AIR QUALITY

Basis for Standards

The Clean Air Act of 1970 requires that the Administrator of the EPA issue air quality criteria which accurately reflect the latest scientific knowledge of the effects varying quantities of ambient pollutants are expected to have on public health and welfare. Air pollutant criteria must include information on:

1) Those variables (including atmospheric) and conditions, which may alter the effects of an air pollutant on public health or welfare,

2) The types of air pollutants which, when present in the atmosphere, may interact to produce an adverse effect on public health or welfare, and

3) Any known or anticipated adverse effects on welfare (060).

Air quality criteria include a description of the effects that can be expected to occur whenever and wherever the ambient air level of a pollutant reaches or exceeds a specific value for a specific time period.

Air quality criteria have been issued by the EPA for the following pollutants: sulfur dioxide, carbon monoxide, suspended particulates, oxidants, oxides of nitrogen, and hydrocarbons. Based on these criteria, available pollution control techniques, and political considerations, EPA has published primary air quality standards for each of these pollutants. Unlike air quality criteria, which are predictive or descriptive, air quality standards are prescriptive; they prescribe pollutant levels that cannot legally be exceeded during a specific time period in a specific geographic area. Air quality standards are of two types, primary and secondary. Primary standards are those which, in the judgement of the EPA Administrator, are necessary to protect the public health. Secondary standards protect the public welfare from any known or anticipated adverse effects associated with the presence of pollutants in the ambient air (060).

National primary and secondary air quality standards are listed in Table A1, Appendix A. Similar standards promulgated by the Missouri Air Conservation Commission are also listed in Table A1, Appendix A.

Air Quality Data

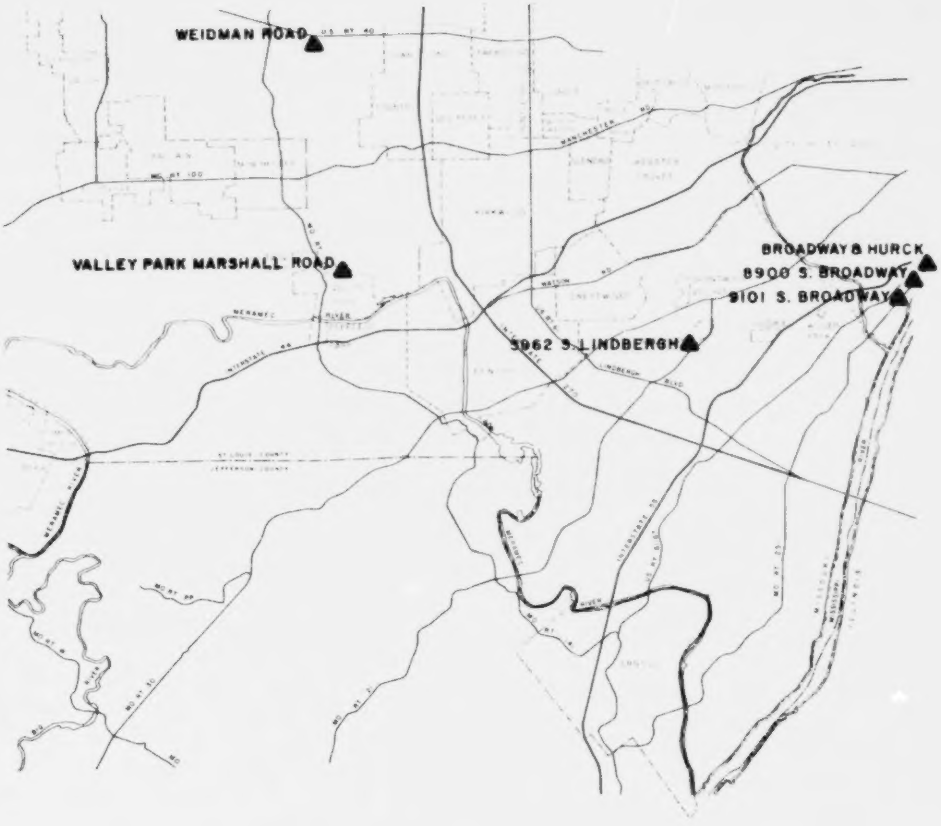
The following agencies collect air quality data in the St. Louis area: 1) St. Louis City Air Pollution Control Department; 2) St. Louis County Air Pollution Control Department; and 3) EPA (in conjunction with the Regional Air Pollution Study). Three county-operated stations (on Weidman Road in western St. Louis County, Marshall Road in Valley Park, and South Lindburgh Road in southern St. Louis County) border the study area. Two city-operated stations at 8900 South Broadway and 9101 South Broadway are northeast of the study area but are in the immediate vicinity of the MSD Lemay Treatment Plant. EPA does not operate any air monitoring stations in the study area (061), and there are no monitoring stations in the Jefferson County portion of the study area (062). The locations of all the above-mentioned stations are shown in Figure 26. No single monitoring station should be taken as representative of the entire project area. In the following paragraphs, a general description of the project area's air quality, based on observations at all available monitoring sites, is presented.

Data Analysis

Suspended particulate concentrations can vary considerably over small distances. In the past 4 years (1972 - 1975), 24-hour concentrations at the 8900 South Broadway station (located in an industrial complex) have often exceeded the standard (063, 064). Maximum 24-hour concentrations at the 9101 South Broadway station (located upwind of these sources, since prevailing winds are from the south) have not exceeded the standard in the last 4 years. The annual geometric mean standard was exceeded in 1975 both at 8900 South Broadway and in Valley Park, the latter site being influenced by excessive dust emissions from nearby roads, construction excavation areas in the immediate vicinity, and a landfill operation 2,000 feet away (063). Since the St. Louis County Air Pollution Control Department has found the Valley Park site to be unrepresentative of the area, a new site is being selected. Based on the limited data available both 24-hour and annual geometric mean standards for suspended particulates may occasionally be exceeded in portions of the study area, especially those portions in proximity to particulate emission sources.

Sulfur dioxide emissions are primarily due to combustion of fossil fuels. Neither 24-hour nor annual arithmetic mean standards were exceeded at either the Weidman Road or South Lindbergh sites in 1975. However, near the MSD Lemay Treatment Plant, a St. Louis City station at Broadway and Hurck violated the 24-hour standard 8 days in 1975 and also exceeded the annual arithmetic mean standard.

Oxidants (mainly ozone) are a component of smog produced through reactions involving hydrocarbons, nitric oxide, sulfur dioxide, and oxygen in the presence of sunlight. These reactions tend to be reduced in the winter due to decreased solar radiation. Maximum 1-hour concentrations of oxidants at both Weidman Road and South Lindbergh frequently exceeded the standard in the years 1972 through 1975. Based on these data, it is probable that 1-hour standards are exceeded on many days during the year throughout the study area, especially in summer months.


WEIDMAN ROAD
VALLEY PARK MARSHALL ROAD
BROADWAY & HURCK
8900 S. BROADWAY
9101 S. BROADWAY
3962 S. LINDBERGH
MANCHESTER RD.
INTERSTATE 44
ST. LOUIS COUNTY
JEFFERSON COUNTY

RETA

FIGURE 26

AIR QUALITY MONITORING STATIONS

Nitrogen dioxide is a primary reactant in the smog formation process. Nitrogen dioxide concentrations are measured at the St. Louis County Air Pollution Control Department's monitoring stations on Weidman Road and South Lindbergh. From 1972 to 1975, the annual arithmetic mean standard was not exceeded. Based on the rather limited data available and the fact that there are few major sources of this pollutant in the study area, nitrogen dioxide concentration at representative locations in the study area will not exceed the annual arithmetic mean standard.

Carbon monoxide concentrations are caused primarily by automobile exhaust emissions. Data gathered at monitoring sites on South Lindbergh and Weidman Road indicate 1-hour standards were not exceeded at either location from 1972 through 1975. However, the data indicates that 8-hour standards may sometimes be exceeded at a particular site in the study area, depending on traffic flow, wind conditions, and atmospheric stability.

No data are available to characterize concentrations of hydrocarbons.

Factors Affecting Air Quality

Pollutant Emissions - The study area's air quality is dependent on pollutant emissions within the area as well as in surrounding counties. Total air pollutant emissions in St. Louis and Jefferson Counties are presented in Table 32. The study area comprises 12 percent of both the land area and the population of these two counties (040, 065). As shown, major pollutant sources within St. Louis and Jefferson Counties include vehicular emissions of carbon monoxide, hydrocarbons, nitrogen oxides, and particulates, emissions of particulates and sulfur dioxide from industrial processes, and fossil fuel combustion used to generate heat and electricity. The degree to which emissions from sources outside the study area affect air quality within the study area is variable and is highly dependent on wind speed and direction, atmospheric stability, and precipitation occurrence.

As mentioned in the climate section of this chapter, the area's location in a valley and varied, relatively rough topography contributes to increased turbulence, wider diurnal wind fluctuations, and more variance in humidity and precipitation patterns than predominates throughout much of the St. Louis area. In general, these factors contribute to the dispersion of pollutants. "Pockets" of higher humidity will be subject to periodic increased formation of sulfurous and sulfuric acids, while areas of increased precipitation will receive cleansing efforts.

TABLE 32

TOTAL POLLUTANT EMISSIONS, JEFFERSON AND ST. LOUIS COUNTIES, 1976

Pollutant Sources	Carbon Monoxide		Hydrocarbons		Nitrogen Oxides		Sulfur Oxides		Particulates	
	tons/yr	% of total	tons/yr	% of total	tons/yr	% of total	tons/yr	% of total	tons/yr	% of total
1. Transportation sources	335,096	98.8	63,604	83.8	39,179	47.5	2,370	1.0	4,958	19.6
Light vehicles	244,065	72.0	38,563	50.8	22,647	27.5	713	0.3	2,750	10.9
Heavy-duty gas and diesel vehicles	83,807	24.7	14,483	19.1	12,946	15.7	1,075	0.5	1,140	4.5
Other (rail, aircraft, vessels, etc.)	7,224	2.1	9,953	13.1	3,586	4.3	582	0.3	168	0.7
2. Solid waste disposal	1,613	0.5	623	0.8	136	0.2	34	<0.1	362	1.4
3. Industrial processes	7	<0.1	9,675	12.8	3,821	4.6	108,807	48.0	12,947	51.2
4. Fuel combustion	2,293	0.7	800	1.1	39,353	47.7	115,464	50.9	7,023	27.8
Electric generation	1,120	0.3	-	-	32,199	39.0	105,826	46.7	3,321	13.1
5. Miscellaneous	-	-	1,170	1.5	-	-	-	-	-	-
TOTAL	339,147	100.0	75,872	100.0	82,489	100.0	226,674	100.0	25,290	100.0

Source: (066)

The study area's air quality is more directly affected by emission sources located within the study area. Major point sources of pollutants within the study area are presented in Table 33; locations are sited in Figure 27. As shown, the Union Electric Meramec Plant is the largest single point source of particulates, sulfur dioxide, nitrogen oxides, and carbon monoxide, while the Chrysler Plant in Fenton is the largest point source of hydrocarbons (007). The study area is also subjected to emissions of an estimated 40,200 tons of carbon monoxide, 7,600 tons of hydrocarbons, and 4,700 tons of nitrogen oxides annually due to various transportation-related sources.

Meteorological Effects - Several meteorological features affect St. Louis' air quality, including wind speed, atmospheric inversions, and precipitation. The St. Louis area is susceptible to high air pollutant concentration when there are light winds, low mixing heights, and no precipitation for two or more days. These meteorological conditions, combined with excessive emissions, can create an air pollution episode. A "ventilation factor" (defined as the product of the mixing height and the wind speed) is a measure of the potential severity of an air pollution episode. Average seasonal and annual wind speeds, mixing heights, and ventilation factors for St. Louis are presented in Table 34. Although mixing heights, wind speeds, and ventilation factors are generally lowest during summer mornings, on most days the sun quickly burns through the inversion raising the mixing height to an average of 1,700 meters and thereby allowing for sufficient mixing. Afternoon mixing heights reach their lowest level during the winter months because of the absence of sufficient solar radiation and, when winds are light, a build-up of air pollutants can occur.

Based on available data and historical meteorological records, conditions conducive to at least mild air pollution episodes (ventilation factor less than or equal to 6,000 m^2/sec for two or more consecutive days) are likely to be present during approximately 10 days per year, and are most likely to occur during the summer months (067, 068). Extended episodes lasting 5 days or more occur only infrequently (less than once per year) and the probability of occurrence is greatest during winter (068).

Significance of Air Quality Problems

Pursuant to 40 CFR 51.12 (e), published June 18, 1973 in the Federal Register, each state is responsible for identifying those areas (counties, urbanized areas, standard metropolitan statistical areas, etc.) which, due to current air quality and/or projected growth rate, may have the potential for exceeding any National Ambient Air Quality Standards within the subsequent

TABLE 33

SIGNIFICANT AIR POLLUTANT POINT SOURCES IN THE STUDY AREA 1976

Pollutant Source Location	Operations	Annual Pollutant Emissions (tons)		
		Particulates	Sulfur Dioxide	Nitrogen Oxides
1. Chrysler Assembly Plant 1001 N. Highway Drive Fenton, MO	Application of primer, paint, enamel, and lacquer; boiler operation	4	<1	240
2. Union Electric 8200 Fine St. Louis County, MO	Incineration of coal and natural gas for power generation	3,133	104,740	32,084
3. Fred Weber South Asphalt Plant 4200 New Baumgartner Mehlville, MO	Rotary drier and boiler	7	13	23
4. Fred Weber South Stone Plant 4200 New Baumgartner Mehlville, MO	Crushing, handling, and storage	1,092	-	-
5. Ramsey Corp. Manchester & Weidman Rds.	Degreasing, manufacturing operations	1	2	2

TABLE 33

SIGNIFICANT AIR POLLUTANT POINT SOURCES IN THE STUDY AREA 1976
(continued)

Pollutant Source Location	Operations	Annual Pollutant Emissions (tons)	
		Hydrocarbons	Carbon Monoxide
1. Chrysler Assembly Plant 1001 N. Highway Drive Fenton, MO	Application of primer paint, enamel, and lacquer; boiler operation	3,742	7
2. Union Electric 8200 Fine St. Louis County, MO	Incineration of coal and natural gas for power generation	309	1,063
3. Fred Weber South Asphalt Plant 4200 New Baumgartner Mehlville, MO	Rotary drier and boiler	<2	<2
4. Fred Weber South Stone Plant 4200 New Baumgartner Mehlville, MO	Crushing, handling, and storage	-	-
5. Ramsey Corp. Manchester & Weidman Rds.	Degreasing, manufacturing operations	66	1

Source: (007)

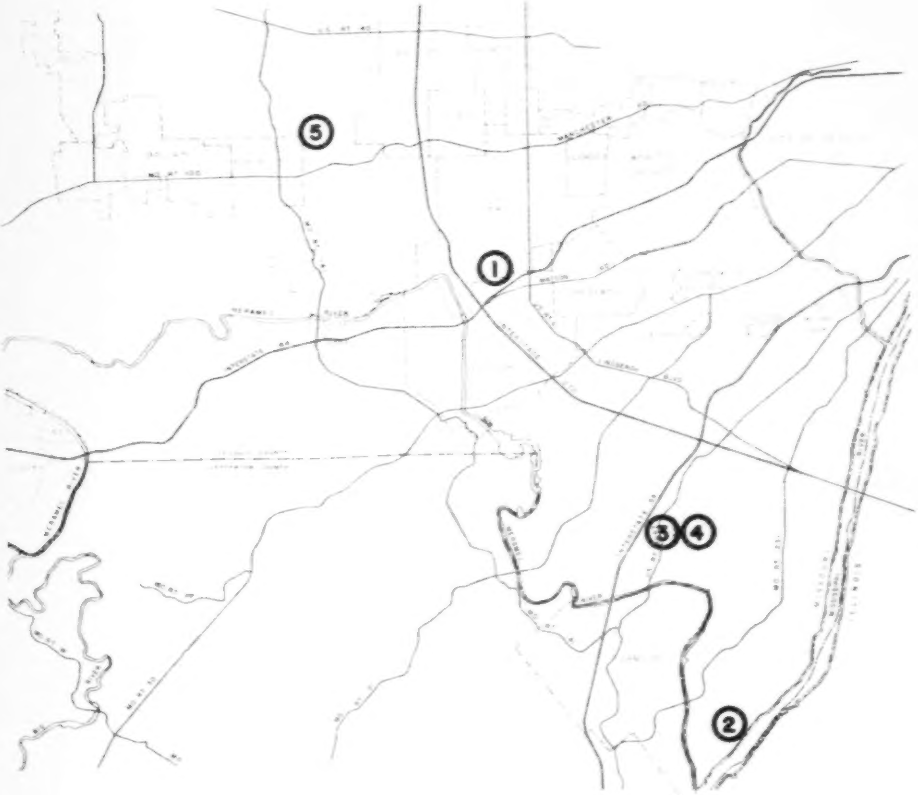
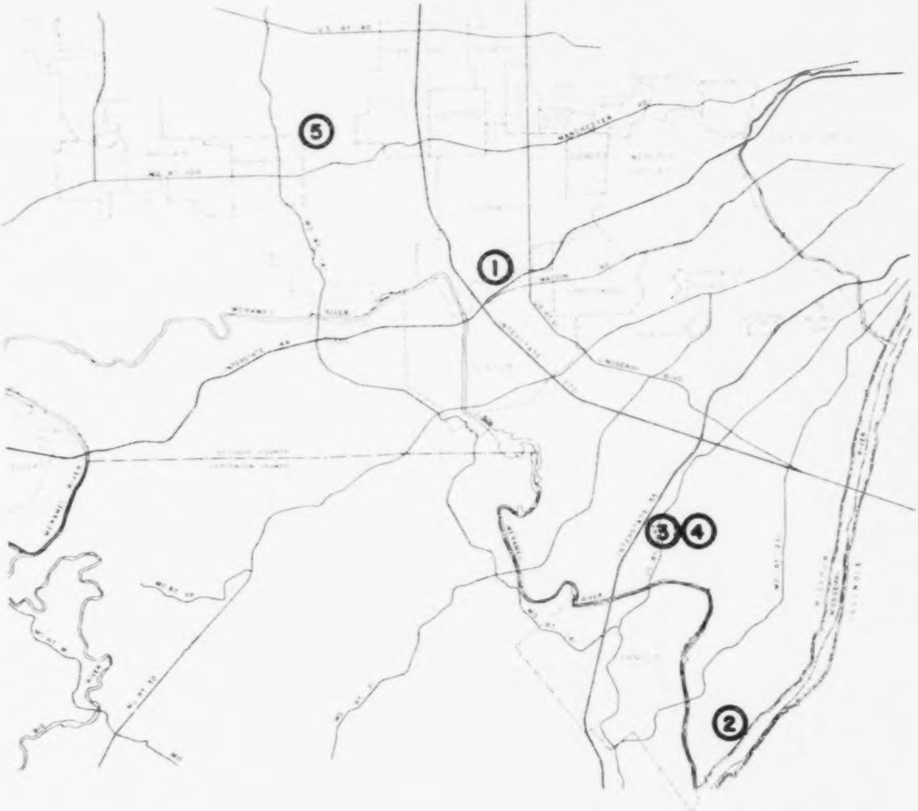

U.S. RT. 40
⑤
MANCHESTER RD.
MO. RT. 100
①
WATSON RD.
MERAMEC RIVER
INTERSTATE 44
LINDBERGH BLVD.
MERAMEC RIVER
③
④
②

FIGURE 27

MAJOR POINT SOURCES OF
AIR POLLUTANTS

Source: (007)


⑤
①
③
④
②
U.S. RT. 40
MANCHESTER RD
WATSON RD
MERAMEC RIVER
INTERSTATE 44
LINDBERGH BLVD
RIVER

RETA

FIGURE 27

MAJOR POINT SOURCES OF AIR POLLUTANTS

Source: (007)

TABLE 34

MEAN MIXING HEIGHTS AND WIND SPEEDS, ST. LOUIS, MO

	Morning			Afternoon		
Period	Mean Mixing Height (meters)	Mean Wind Speed (m/sec)	Morning Ventilation Factor (m^2/sec)	Mean Mixing Height (meters)	Mean Wind Speed (m/sec)	Afternoon Ventilation Factor (m^2/sec)
Winter	450	6.0	2,700	900	7.0	6,300
Spring	500	6.5	3,250	1,550	8.5	13,175
Summer	350	4.5	1,575	1,700	5.5	9,350
Autumn	375	4.5	1,687	1,300	6.5	8,450
Annual Average	400	5.5	2,200	1,400	7.0	9,800

Source: (068)

10-year period. Such an area is designated as an Air Quality Maintenance Area (AQMA). Each state must perform a thorough air quality analysis of each of these areas. If analysis results indicate that an area definitely will not maintain standards during the 10-year period, a plan defining how that standard will be maintained must be developed (069).

The St. Louis Air Quality Control Region, which includes all of St. Louis City, St. Louis County, Jefferson County, and eight surrounding counties in Illinois and Missouri, has been designated an AQMA for the following pollutants: suspended particulates, sulfur dioxide, and oxidants (069). State and local agencies are currently developing strategies to insure air quality standards will be attained and preserved in future years (062, 063, 064). Strategies will most likely include:

1) Control of major point sources

2) Automotive fuel vapor recovery

3) Recovery of volatile hydrocarbon vapors from stationary sources (e.g., dry cleaning, painting operations, and degreasing)

4) Transportation improvements, including consideration of exclusive bus-car pool lanes, park and ride systems, car-pooling locator system, staggered work hours, parking limitations, and traffic light synchronization

5) Inspection and maintenance of mobile sources (070)

In the preliminary analysis of the severity and causes of air quality problems in the St. Louis AQMA, the area within a 1-mile radius of 8900 South Broadway in St. Louis City has been identified as a "hot spot" where suspended particulate and sulfur dioxide concentrations currently exceed and are expected to continue to exceed standards because of its proximity to established point sources (063). Special control strategies will probably be developed for such problem areas. Although the nature of these strategies is not currently known, they may have an impact on the operation of pollutant sources within the "hot spots", including the MSD Lemay Sewage Treatment Plant at 9200 South Broadway.

If standards continue to be violated in any of the "hot spots" identified in monitoring programs, state strategies call for requiring polluters to use the best available control technology and/or restriction of the development of new sources. Hence, such a continuance would result in either a halt to development or the placement of a severe economic burden on industries of a given area.

BIOLOGICAL RESOURCES

Terrestrial Habitat

The Lower Meramec River Basin study area has a wide variety of habitat types. The forested uplands, slopes, and bottomlands comprise about 284,700 acres in Jefferson and St. Louis Counties (071). The study area's pastures, cultivated fields, and old fields are associated with disturbed land, or areas in which the vegetational components are undergoing secondary succession. The smaller streams of the study area are prime habitat for a variety of amphibians, reptiles, and birds, as well as plant species which prefer lotic habitats. There are numerous caves and springs throughout the study area which provide unique habitats for a number of biological elements. Many species are indigenous only to cavernous habitats, and as a result, have been included on the Missouri Rare and Endangered Species List (072) (e.g., the Indiana bat, *Myotis sodalis*, and the gray bat, *Myotis grisescens*).

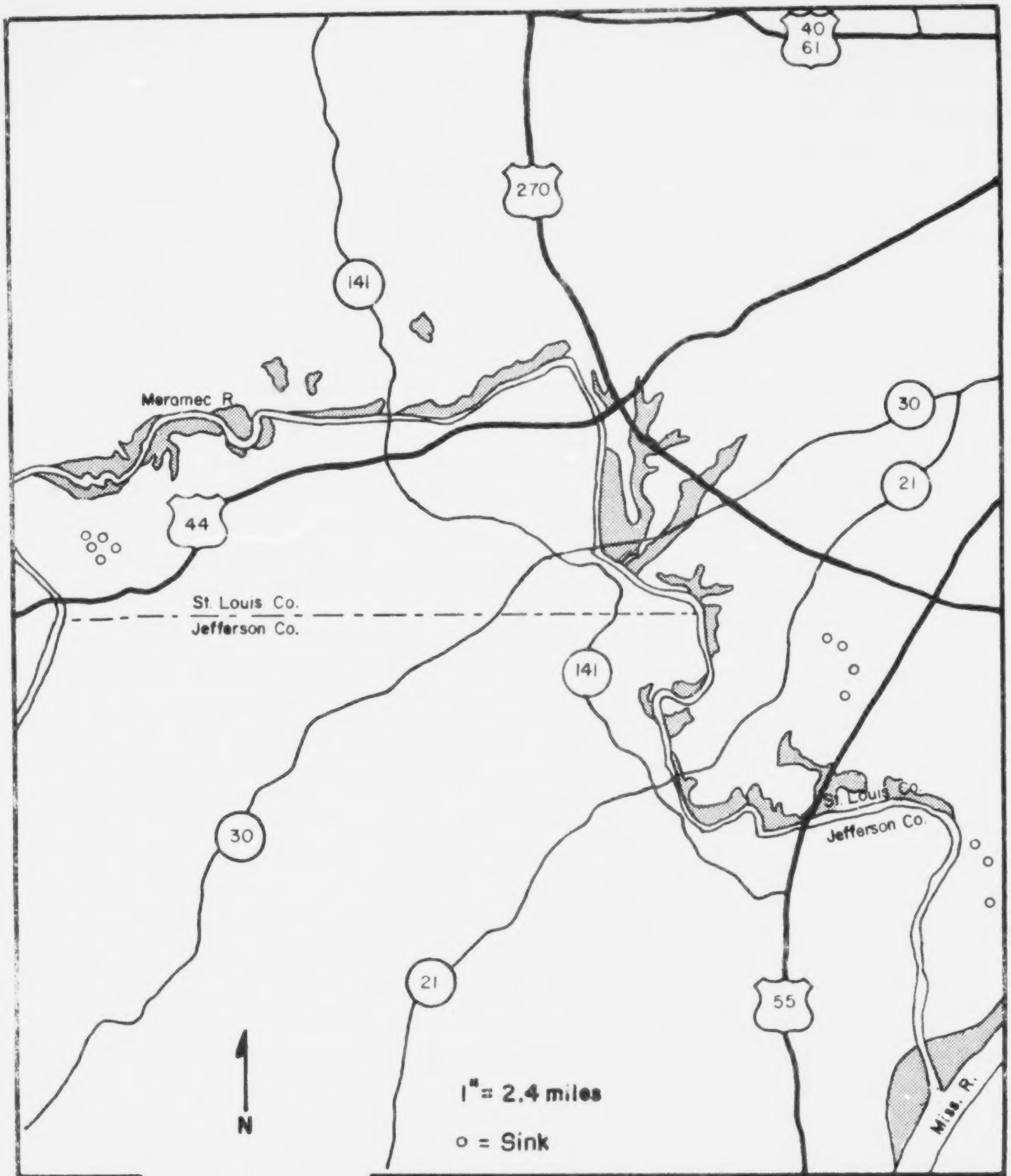
The combination of frequent flooding and slow draining soils in parts of the study area has resulted in a significant acreage of potential "wetland habitat" including backwater areas, portions of bottomlands, and some small sloughs and ponds. Most of this acreage has been severely modified by provision of agricultural drainage and landform manipulation for development. No known tracts remain which would be properly termed "wetlands" from a plant-composition standpoint. The areas indicated on Figure 28, while of relatively little significance in terms of species rare to Missouri or to the United States, do function as important wildlife food sources for the study area.

Vegetation

The Lower Meramec River Basin lies entirely within the vegetation region designated as the Ozark Region (073). Floral elements reported in the study area are listed in Table A 2 in Appendix A. Dominant and typical species for each major association are given in Table 35.

Wildlife

Mammals - The Lower Meramec River Basin provides a variety of suitable habitats for many mammalian species. The forested uplands, slopes, and floodplain provide cover and forage areas for many


40
61
270
141
Meramec R.
30
21
44
St. Louis Co.
Jefferson Co.
141
St. Louis Co.
Jefferson Co.
30
21
55
N
1" = 2.4 miles
○ = Sink
Miss. R.

RETA

R806

FIGURE 28

POTENTIAL WETLAND HABITAT AREAS
BASED ON SOILS DATA
LOWER MERAMEC RIVER BASIN

Source: (021, 074, 075, 076, 017, 077)

TABLE 35

VEGETATIVE ASSOCIATIONS OF THE LOWER MERAMEC RIVER BASIN

Association	Habitat	Dominant/Typical Species	Successional Trend
Aquatic Macrophytes	Littoral zone of small lakes	Cattail, American lotus, arrowhead, water willow, duckweeds.	To eutrophic lake; to bottomland
	Backwater sloughs, riverbanks, sluggish streams.	Water plantain, water milfoil, arrowhead, pondweed.	To bottomland forest; maintained by flooding.
Upland Forest	Acidic dry substrates in uplands	Sassafras, winged sumac, fragrant sumac, persimmon.	To blackjack oak - post oak; maintained by thin soil.
	Acidic dry substrates in uplands.	Blacksack oak. post oak, broom sedge, panic grasses.	To oak-hickory climax; mained by thin soil.
	Dry ridges, uplands, upper slopes - more developed acidic soils.	Black oak, hickory, northern red oak, sassafras blueberry, farkleberry.	Climax
Slope Forest	Xerophytic bare limestone.	Side-oats grama, perennial black-eyed susan, Missouri primrose, white wild indigo, pale purple coneflower, purple prairie clover, panic grasses, big bluestem, little bluestem.	To fragrant sumac-red cedar; maintained by dryness & thin soil.
	Limestone with thin soil cover.	Fragrant sumac, red cedar, persimmon, shumard oak, redbud; hawthorne, hackberry, and Carolina buckthorn later.	To chiuquapin oak - white ash maintained by thin soil.
	More developed soils	Chinquapin oak, white ash, blue ash, hop hornbeam, bristly greenbrier.	To sugar maple - white oak; maintained by immature soil.
	Most fully developed slope.	Sugar maple, white oak, northern red oak, linden, butternut, flowering dogwood, spicebush, bladdernut.	Climax
Bottomland Forest	Sand & gravel bars adjacent to River.	Black willow, witch hazel, river birch, sycamore, rough dogwood, rushes, sandgrape, trumpet creeper, yellow nut grass.	To cottonwood - silver maple; maintained by flooding.
	Rich alluvial deposits	Silver maple, cottonwood, river birch, blackwillow, buttonbush, green ash, box elder, tall white aster, smartweed.	To American elm - green ash; maintained by high water table.
	Drainage valleys and runoff areas	American elm, green ash, sugar maple, bur oak, shumard oak, box elder.	Climax
	Floodplain - rich alluvial soil back from water.	Sugar maple, bitternut hickory; white oak in more elevated areas. Merges with above association at confluence with runoff areas.	Climax

TABLE 35

VEGETATIVE ASSOCIATIONS OF THE LOWER MERAMEC RIVER BASIN
(Continued)

Association	Habitat	Dominant/Typical Species	Successional Trend
Pastures	Planted nearly level areas - grazed.	Timothy, smooth brome.	NIA; succession stopped by cultivation.
	Nearly level unplanted areas - grazed.	Redtop, Kentucky bluegrass, milkweed, ironweed, buttercup; little bluestem if lightly grazed; if long unplanted, side-oats grama, Indian grass, daisy Fleabane.	To prairie or climax forest, maintained by grazing.
Cultivated Fields	Gently sloping to nearly level areas.	Row crops, fleabane, milkweed, crabgrass, dandelion, foxtail, clover, lamb's quarters, black-eyed susan.	NIA; succession stopped by cultivation.
Old Fields	Once cultivated; now abandoned, gently - sloping areas - first 10 years.	Dependent on former use; old cornfields - crabgrass, horseweed, ragweed, goldenrod; old Timothy & redtop fields - Canada thistle, mustard, wild carrot, fleabane.	To prairie or forest.
	Same habitat - approximately 10 years	Shrub succession; coralberry, sumac persimmon, sassafras, wild cherry, box elder, morning glory, yellow wood sorrel, junipers, oaks, hickories.	To prairie or forest; assume character of surrounding vegetation.
Cave Entrances		Mosses & liverworts, ferns, annual weeds.	Maintained by shade as climax or succession to surrounding vegetation.
Springs		Mosses, liverworts, water milfoil, water cress, water starwort, bulbrushes	Maintained by moisture or mineralization.
Urban Areas		Introduced ornamentals, pin oak, silver maple, box elder, sycamore, elm; prairie remnants along railroad tracks and freight yards	Seral stage usually stopped.

species, and even urban areas maintain ample habitat for some mammals. Mammalian species reported to occur in the Lower Meramec Basin study area are listed in Table A3 in Appendix A. Typical mammals of the area by habitat preference are listed in Table 36.

Herptiles - The Meramec River Basin study area supports a variety of reptiles and amphibians that can be found in many types of habitats from the alluvial bottomlands to the upland forests. Herptiles occurring in the Lower Meramec River Basin are listed in Tables A4 and A5 in Appendix A. Typical species in the area, by habitat preference,are listed in Table 37.

Birds - The Lower Meramac River Basin provides adequate breeding and overwintering grounds for many migratory as well as resident bird species. Avian species which have been observed either in migration or residence in the Lower Meramec River Basin are listed in Table A6 in Appendix A. Table 38 lists some typical bird species and the areas in which they are most frequently encountered (termed "habitat" in the table).

Rare and Endangered Terrestrial Species

There are 10 mammals, 3 herptiles, 18 birds, and 113 plant species included on the Rare and Endangered Species of Missouri List that occur in the Lower Meramec River Basin (072). The Missouri Department of Conservation defines these species and their appropriate status as follows (072):

> Endangered: An endangered species or subspecies is one whose prospects for survival within the state are in immediate jeopardy. Its peril may result from one or many causes - loss of habitat or change in habitat, overexploitation, predation, competition, disease. An endangered species must have help or extirpation will probably follow.
>
> Rare: A rare species or subspecies is one that, although not presently threatened with extirpation, is in such small numbers within the state that it could easily become endangered if its environment worsens. Close watch of its status is necessary.
>
> Status Undetermined: A status undetermined species or subspecies is one that has been suggested by competent authority as possibly rare or endangered, but about which there is not enough information to determine its status. More information is needed, but it should be considered rare or endangered until its definite status is established.

TABLE 36

TYPICAL MAMMALS OF THE LOWER MERAMEC RIVER BASIN

Habitat	Typical Mammals
Upland and Slope Forest	Eastern fox squirrel, eastern gray squirrel, southern flying squirrel, eastern cottontail, white-tailed deer, woodland white-footed deermouse.
Bottomland Forest	Short-tailed shrew, western harvest mouse, silver-haired bat, red bat, opossum.
Riverbanks	Raccoon, mink, beaver, woodchuck, muskrat, eastern mole.
Peripheral Areas of Woodland	Chipmunks, striped skunk, coyote, red fox, gray fox.
Pastures and Old Fields	White-tailed deer, woodchuck, prairie white-footed mouse, prairie vole.
Cultivated Fields	Plains pocket gopher, prairie vole, white-footed mouse, eastern cottontail.
Caves and Cliffs	Gray bat, Keen's bat, Indiana bat, little brown bat, big brown bat, eastern pipistrelle.
Urban Areas	Squirrels, raccoons, striped skunk, opossum, eastern cottontail, house mouse, Norway rat.

TABLE 37

TYPICAL REPTILES AND AMPHIBIANS OF THE LOWER MERAMEC RIVER BASIN

Habitat	Typical Reptiles and Amphibians
Upland and Slope Forests	Spotted salamander, American toad, gray tree frog, five-lined skink, three-toed box turtle, speckled king snake, midland brown snake, northern copperhead, timber rattlesnake, Great Plains rat snake, red milk snake.
Alluvial Bottomlands	Marbled salamander, tiger salamander, gopher frog, small-mouthed salamander, spring peeper, western chorus frog, pickerel frog, bullfrog, southern coal skink, rough green snake, western ribbon snake.
Aquatic habitat	Common snapping turtle, stink pot, western spring soft-shelled turtle, and northern water snake.
Old Fields, Pastures, Open Areas Near Wooded Tracts	American toad, Fowler's toad, northern leopard frog, eastern garter snake, northern fence lizard, ornate box turtle, Six-lined racerunner, eastern coachwhip, northern copperhead, prairie kingsnake.
Caves and Springs	Cave salamander, long-tailed salamander, Cope's cave salamander, slimy salamander, pickerel frog.

TABLE 38

TYPICAL BIRDS OF THE LOWER MERAMEC RIVER BASIN

Habitat or Forage Area	Typical Birds Encountered
Upland Forests	Downy woodpecker, red-headed woodpecker, red-bellied woodpecker, cardinal, bluejay, woodthrush, flycatcher, vireas, orioles, tanagers, eastern turkey.
Bottomland Forests	Great blue heron, common egret, double-crested cormorant, swamp sparrow, dark-eyed junco, rufous-sided towhee, ruby-crowned kinglet, ducks, geese, migratory woodcock, snipe.
Pastures, Old Fields, and Cropland	Quail, mourning dove, ring-necked pheasant, meadowlark, sparrows, red-winged blackbird, crow. Habitat and forage for upland plover, sharp-shinned hawks, and Cooper's hawk, all three of which are considered endangered in Missouri.
Urban Areas	Starling, mockingbird, pigeon, robin, cardinal, bluejay, song sparrow.

Extirpated: An extirpated species or subspecies is one that formerly occurred in Missouri, but at this time is not known to exist within the state. Extirpated species still occur elsewhere and could become established in Missouri if conditions become favorable.

Mammals - Of the 18 mammalian species that the Missouri Department of Conservation lists as rare and endangered in Missouri, 10 of these species occur in the Lower Meramec River Basin (see Table A7 in Appendix A). Three of these species, Indiana bat, gray bat, and the red wolf, are also classified as endangered on the federal list. Six of these species are bats which inhabit several caves found throughout the area. Other species included on the list are the red wolf (Canis niger), the black bear (Ursus americanus), the long-tailed weasel (Mustela frenata), and the river otter (Lutra canadensis). Lack of evidence concerning the occurrence or range of the red wolf in Missouri has resulted in its possibly extirpated status (078).

Herptiles - Only three herptiles of the 13 listed on the Missouri Rare and Endangered Species List occur in the Lower Meramec River Basin (see Table A8 in Appendix A). None of these are classified rare, endangered or threatened on the federal list. The four-toed salamander (Hemidactylium scutatum) only occurs in small relict populations in eastern and southeastern Missouri. The larvae are generally found near springs with sphagnum moss, while the adults are terrestrial (021). The wood frog (Rana sylvatica) is known to occur in isolated pockets in southwestern Missouri; however, it is possible that it may occur in east-central Missouri. The wood frog is generally confined to mesophytic forest habitats where permanent or semi-permanent pools exist. This species may possibly be extirpated from the Lower Meramec River Basin (021). The alligator snapping turtle (Macroclemys temmincki) prefers large, turbid streams in the southeastern lowlands of Missouri, but its distribution includes St. Louis and Jefferson Counties. Its range is generally confined to states bordering the Gulf Coast and the Mississippi River (079).

Birds - There are 18 species of birds included on the Missouri Rare and Endangered Species List which occur or could occur in the Lower Meramec River Basin. Two of these, the peregrine falcon and the Northern bald eagle, are considered federally endangered. Some localities where particular species have been observed are so close to the study area that the probability of these species occurring within the study is great (i.e., avian species reported near the City of St. Louis). Many bird species uch as the sharp-shinned hawk, the osprey (Pandion haliaetus), and the peregrine falcon (Falco peregrinus) are seen only during migration and do not nest in the area. Others such as Bachman's sparrow (Aimophila aestivalis) and the Mississippi kite (Ictinia misisippiensis) may nest in the area. The destruction of prairie and marsh habitats has caused a decline in certain species populations including the king rail (Rallus elegans) and the upland plover. Rare and endangered bird species of the Lower Meramec River Basin are listed in Table A1 in Appendix A.

Plant Species - There are approximately 113 plant species considered rare and endangered on the Missouri and/or federal lists which occur in the Lower Meramec River Basin (see Table A10 in Appendix A). Of the 113 species, 83 are floral elements that have been introduced and naturalized generally in the St. Louis area. Although these species are not regarded as rare and endangered in their indigenous habitat, they are generally scarce in Missouri and, for this reason, are discussed in this section. Naturalized species include the scrub pine (Pinus virginiana), hair grass (Aira elegans), water dock (Rumex orbiculatus), and tall buttercup (Ranunculus acris var. acris) (072,076). These are just a few examples of introduced plants, most of which have been able to adapt to disturbed habitats (e.g., areas along railroad tracks and waste ground). The remaining 30 species are plants that are native to the Lower Meramec River Basin. Many have suffered from habitat destruction, such as a member of the water plantain family (Echinodorus tenellus var. parvulus) which was originally collected along the margins of ponds that have since been destroyed (076). This species is now considered rare in Missouri and may even be extirpated from the state. Several other species considered rare in Missouri include the cut-leave grape fern (Botrychium dissectum var. dissectum), Douglas' bulbrush (Carex douglasii), green adder's mouth (Malaxis uniflora f. uniflora), and broom-rape (Orobanche ludoviciana), a parasitic species. The elms are also included in the endangered category as a result of Dutch Elm Disease (072).

Aquatic Habitat

The channel characteristics of the Lower Meramec River within the study area range from very long, deep pools with few broad, undefined riffles near the river mouth to somewhat smaller pools associated with more frequent short, swift riffles at the upper end of the reach. Bottom substrate near the river mouth consists of about 85 percent rubble, 5 percent boulders and 10 percent gravel (021). In comparison with the Upper Meramec River, the lower reach has a much flatter slope and, therefore, slower flow. During high water periods on the Mississippi River, backwater can flood the Meramec as far upstream as Valley Park. This constitutes the entire river reach within the study area (080, 001).

The Upper Meramec River is the principal water source of the Lower Meramec River (rather than large springs, tributaries, or groundwater inflow), and water temperatures correspond to the normal air temperature (081). The slower flow of the lower river reach and its long, wide, and unshaded pools are more conducive to algae growth and resultant organic turbidity (081) Most suspended sediment discharge in the lower Meramec River occurs during short periods of high stream flow (082). Records of fecal coliform sampling analysis from the U. S. Geological Survey station (about 10 miles upstream of the river's mouth) indicate that river pollution from bacteria is mostly due to animal wastes from livestock operations. Based on water quality parameter means for the years 1966 to 1970 (082), the lower river is slightly alkaline, has relatively hard water, and is not harmful to endemic aquatic biota.

Good fish cover is generally scarce; the cover that is available consists of widely scattered brush piles, bank trash, and detritus (021). The number of desirable fish species decreases downstream, probably as a result of gravel and sand dredging, increased runoff, and the combined effects of inadequate sewage treatment in the study area. The general lack of good cover, the greater proportion of deepwater, and increased pollution indicate that there is also reduced downstream species diversity among the benthic macroinvertebrates, although corroborating biological collection data are scarce.

The substrates of the numerous small tributaries of the Lower Meramec are generally rubble and gravel in the upper watersheds. Substrates gradually change to gravel and sand and then silt towards the mouths (074). Due to their shallowness, tributary creeks do not appear to provide a significant amount of habitat for fishes during normal to low flow, except in the immediate reach at their mouths. However, since sufficient food (particularly benthic macroinvertebrates and allochthonous terrestrial organisms) appears to be available, the creeks probably can support limited populations of certain species of cyprinid minnows and one or two species of darters (family Percidae) where pollution is not a limitation. Grand Glaize Creek is the most severely degraded of the creeks, mainly because of its organic pollution (074).

Aquatic Organisms

Plankton - Plankton are plants and animals suspended in a body of water and incapable of sustained mobility in a direction counter to water current. Most plankton are microscopic, of neutral buoyancy, and all drift with the currents. Chlorophyll-bearing phytoplankton usually constitute the greater portion of plankton biomass. Zooplankton and other herbivores graze upon phytoplankton and, in turn, are preyed upon by other organisms. In this manner, nutrients become available to larger organisms such as benthic macroinvertebrates and, ultimately, to fish (083). In waters polluted by organic matter (such as sewage), heterotrophic microorganisms can become extremely abundant. In turn, these microorganisms produce high concentrations of inorganic nutrients. When available in sufficient quantity, such nutrients provide food for, and result in, massive algal blooms. Such algal or plankton blooms can cause extreme fluctuations in dissolved oxygen levels and endanger fish (083).

Phytoplankton: The quantity of phytoplankton occurring at any one point in a stream depends on factors such as stream volume, season, time of day, stream nutrient content, and presence of toxic materials (083).

No continuous phytoplankton sampling data on the Meramec River or its tributaries within the study area are available. However, qualitative sampling of algae in the Meramec River was performed periodically during 1962 and 1963 at three stations within the study area (081). Data for Station M-11 (stream mile 34 near Times Beach), Station M-12 (stream mile 19 below Valley Park), and Station M-13 (stream mile 5.5 at the Highway 67 Bridge) are listed in Table A11 in Appendix A. These stations are shown in Figure 41. A total of only 27 algal genera were identified. A recent study (075) concerning sampling of the Salt River in northeast Missouri (which is similar in many respects to the Meramec River) described 250 algal taxa, including 183 new Missouri species. In view of this study, it appears that the Meramec River data is very inadequate and does not reflect the actual number of algal genera.

Zooplankton: In progressively lower reaches of a river, current is reduced, water temperature gradually increases and other conditions become somewhat more suitable to the needs of zooplankton. Their increase is closely associated with increases in phytoplankton numbers. However, although it is known that groups characteristic of lentic waters (e.g., rotifers, copepods and cladocerans) become more common, no quantitative data on zooplankton in the lower Meramec or its tributaries are available. (075).

Benthic Macroinvertebrates - Benthic macroinvertebrates are macroscopic animals that live at least part of their life cycles within or upon available substrates in the river (e.g., insects, annelids, mollusks, flatworms, roundworms and crustaceans) (083). The well balanced stream macroinvertebrate community contains omnivores, carnivores and herbivores. The stability of this community is reflected by the stability of the fish community. The assemblage of benthic macroinvertebrates in a stream reach is important because it reflects the relative purity or pollution of the water flowing through that reach. Degradation of the stream's physical or chemical characteristics usually results in the reduction of kinds and numbers of intolerant species while, concurrently, the numbers of a few tolerant species increase greatly. Aquatic insect larvae have become accepted as biological indices of stream water quality (021).

No continuous benthic macroinvertebrate sampling has been performed on streams within the study area (021). The only known sampling was performed in riffles of the Lower Meramec River during 1962 and 1963 (081). For comparison purposes, data on the nearest upstream sampling station (Times Beach) will be discussed along with data on two stations within the study area; one approximately 4 miles downstream of the Valley Park sewer outfall and the second located at the Highway 67 Bridge.

Collections at Times Beach (Station M-11, see Figure 41) included 51 benthic taxa, a large proportion of which were "clean water" organisms (see Table A12 in Appendix A). The substrate was stable, and the stream relatively unpolluted. Collections below Valley Park (Station M-12, see Figure 29) contained 44 benthic taxa, including more than 50 percent "clean water" types. Certain organisms were indicative of serious pollution problems including organic pollution. The lower station collections at the Highway 67 Bridge (Station M-13) contained 55 benthic taxa and were indicative of high water quality (081).

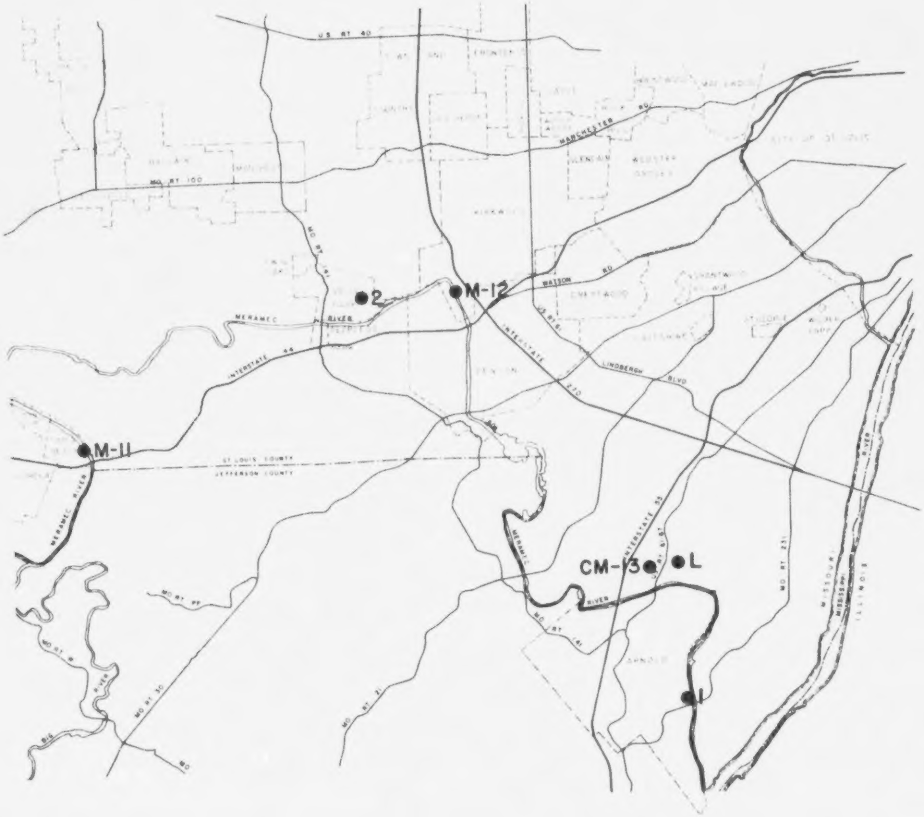
In terms of taxonomic diversity, the naiads of Ephemeropterans were most represented among benthic macroinvertebrate groups at all three sampling stations (see Table A12 in Appendix A). The nymphs Plecopterans were the next most diverse group at the upper two stations, while mollusks, especially mussels, were the third most diverse group at the lower station.

Although these data are important, they do not necessarily indicate the current diversity and occurrence of benthic organisms in the respective river reaches since many factors, particularly organic pollution, could have produced significant alterations in the past 10 years. Mollusks (particularly Pelecypods or mussels) are a very important component of the

Meramec River Basin's benthic organisms. The Meramec Basin streams are the only streams in the St. Louis area which contain a large, varied population of mussels (075). The Meramec River supports a larger number of mussel species than any other Missouri river. The lower Meramec's warm temperature, sustained moderate to large flow, and slightly turbid water which is rich in zooplankton, provides a suitable mussel habitat. Stable gravel, sand, and mixtures of sand, gravel, and silt often support high population levels. Mussels known to occur in the river at Fenton are listed under Station 4 in Table A13 in Appendix A. Collections made at Times Beach (Station 3) are provided for comparison purposes (021). Since mussel sampling has not been on a continuous basis, trends or indications of relative change in stream pollution level cannot be discussed.

Fish - The Lower Meramec River Basin is located in an area which has the richest fish fauna in North America (075). The basin has a total of 105 fish species, just four less that the largest number of species found in any other Missouri river basin (084). William L. Pfleiger, of the Missouri Department of Conservation, analyzed fish collection data from Missouri streams and developed several fish faunal groups that closely correspond to Missouri's major physiographic regions and reflect the influence of environmental factors (084). In the early 1960's, fish collections were conducted at two general areas within the study area: 1) near the town of Valley Park, (Station 2, see Figure 29), and 2) near the Meramec River mouth (Station 1) (021). These sites should comprehensively represent the fishery of the Lower Meramec because the upper collection area should contain a number of species usually associated with environmental factors and habitats of Ozark headwater reaches, while the lower collection area should contain a majority of species usually associated with the big river habitat. It should be noted, however, that the entire reach of the Meramec River within the study area is subject to the backwater flooding of the Mississippi River. This frequently permits fish species typical of the Mississippi River to move into and up the flooded Meramec.

The analysis of collection data for the upper site showed the fishes present belonged to Pflieger's fish faunal classifications as follows (084): Big River, 20 to 30 percent; Wide Ranging, 10 to 20 percent; Prairie, 1 to 10 percent; Ozark, 1 to 10 percent; Ozark-Lowland, 1 to 10 percent; and Ozark-Prairie, 1 to 10 percent. Fishes collected at the lower site were classified as follows: Big River, 40 to 50 percent; Wide Ranging, 10 to 20 percent; Prairie, 1 to 10 percent; and Ozark-Lowland, 1 to 10 percent. These data indicate that the Lower Meramec fishery within the study area consists of succeedingly higher proportions of fishes associated with the Big River faunal group as one proceeds downstream towards the river mouth. Wide ranging faunal group


U.S. RT 40
MANCHESTER RD
CITY OF ST. LOUIS
GLENDALE
WEBSTER GROVES
MO. RT 100
KIRKWOOD
MO. RT 141
●2
●M-12
WATSON RD
CRESTWOOD
MERAMEC RIVER
INTERSTATE 44
U.S. RT 61
INTERSTATE 270
LINDBERGH BLVD
FENTON
●M-11
ST. LOUIS COUNTY
JEFFERSON COUNTY
MERAMEC RIVER
MERAMEC RIVER
INTERSTATE 55
CM-13●
●L
MO. RT 231
MISSOURI
MISSISSIPPI RIVER
ILLINOIS
MO. RT PP
MO. RT 141
ARNOLD
●1
MO. RT W
BIG RIVER
MO. RT 30
MO. RT 21
MO

RETA

FIGURE 29

LOCATIONS OF AQUATIC BIOLOGICAL COLLECTION STATIONS species and species of the Ozark-Lowland group appear to be evenly distributed over the study area river. Predictably, species associated with Ozark aquatic habitat and physiography were present in greater numbers at the upstream site since Ozark faunal group species are generally intolerant of siltation and continuous high turbidity and require a dependable, permanent flow and a predominance of coarse gravel or rocky substrate (084). Fish species collected at the two sites are listed in Table 39. Both seining and boom electroshocking were employed to capture fish. Although the species list does not necessarily contain all species present in the river, it does provide a rough estimate of the community composition and relative population numbers.

Another sampling study of the Lower Meramec River fishery was conducted in 1971. Sampling stations were located from about 1 mile above the Times Beach area, approximately 5 miles upstream of the study area, (shown as Station M-11 on Figure 29), to about 1 mile downstream of the Highway 67 Bridge, about 5 miles upstream of the Meramec River mouth (shown as Station L on Figure 29). Collection data indicated the number of desirable sport fish species decreased in a downstream direction. This was interpreted as a reflection of increased human disturbance of the river (021). Smaller fish species were not adequately sampled, because of the types of capture techniques employed. The carrying capacity of the river appeared to increase in a downstream direction, possibly because of sewage enrichment. Fish species captured and/or observed and their relative frequency are listed in Table 40. It should be noted that in 1971 gizzard shad (Dorosoma cepedianum) were far more abundant than other larger fish species.

All fish species known to occur in the Meramec River Basin are listed in Table A14 in Appendix A. It is possible that any of these species could occur within the study area river reach at some time due to factors such as backwater flooding, fish movements, normal occurrence or downstream displacement.

Although information is not available on fish species present in creeks tributary to the Meramec River within the study area, it is reasonable to expect that many of the smaller species (e.g., Cyprinid minnows) inhabit these creeks at their mouths, if pollution or some physical barrier does not occur there. In addition, many species could migrate considerable distances up the creeks during Mississippi River flooding periods (e.g., gizzard shad, carp [Cyprinus carpio], gar [Lepisosteus sp.], mosquito fish [Gambusia affinis], topminnows [Fundulus sp.], mooneye [Hiodon tergisus], and goldeye [Hiodon alosoides]).

TABLE 39

SPECIES OF FISH TAKEN BY ELECTROSHOCKING
LOWER MERAMEC RIVER,
STATIONS 1 AND 2[a]
JUNE 1971

		Total River Surveyed 1971	
Common Name	Scientific Name	Number(s) Captured	Percent of of Catch
Chestnut lamprey	*Ichthyomyzon castaneus*	-	-
Paddlefish	*Polyodon spathula*	(b)	-
Longnose gar	*Lepisosteus osseus*	-	-
Shortnose gar	*Lepisosteus platostomus*	-	-
Bowfin	*Amia calva*	4	<1.0
Gizzard shad[c]	*Dorosoma cepedianum*	(d)	50.0
Goldeye	*Hiodon alosoides*	-	-
Mooneye	*Hiodon tergisus*	-	-
Carp	*Cyprinus carpio*	150	8.0
Golden shiner	*Notemigonus crysoleucas*	-	-
River carpsucker	*Carpiodes carpio*	19	1.1
Smallmouth buffalo	*Ictiobus bubalus*	24	1.3
Bigmouth buffalo	*Ictiobus cyprinellus*	46	2.5
Spotted sucker	*Minytrema melanops*	3	<1.0
Shorthead redhorse	*Moxostoma macrolepidotum*	30	1.7
Black bullhead	*Ictalurus melas*	-	-
Yellow bullhead	*Ictalurus natalis*	-	-
Channel catfish	*Ictalurus punctatus*	7	<1.0
Madtom	*Noturus exilis*	-	-
Flathead	*Pylodictis olivaris*	4	<1.0
American eel	*Anguilla rostrata*	-	-
White bass	*Morone chrysops*	17	<1.0
Rock bass	*Ambloplites rupestris*	7	<1.0
Warmouth	*Lepomis gulosus*	1	<1.0
Green sunfish	*Lepomis cyanellus*	-	-
Bluegill	*Lepomis macrochirus*	105	5.8
Longear sunfish	*Lepomis megalotis*	180	9.9
Smallmouth bass	*Micropterus dolomieui*	13	<1.0
Largemouth bass	*Micropterus salmoides*	96	5.3
White crappie	*Pomoxis annularis*	108	5.9
Black crappie	*Pomoxis nigromaculatus*	6	<1.0
Logperch	*Percina caprodes*	-	-
Sauger	*Stizostedion canadense*	20	1.1
Walleye	*Stizostedion vitreum*	4	<1.0
Freshwater drum	*Aplodinotus grunniens*	59	3.3

NOTES: [a] See Figure 27 for location of Stations 1 and 2

[b] Paddlefish observed but not actually captured

[c] Density of gizzard shad estimated at 50 percent of the total catch

[d] Numbers of shad arbitrarily added to the total of others reported for purposes of calculation

Source: (021)

TABLE 40

FISHES COLLECTED IN THE LOWER MERAMEC RIVER
STATIONS M-11 AND L[a]
JULY 1963

Species	Lower Site	Upper Site
Longnose gar	1	2
Shortnose gar	1	2
Gizzard shad	178	74
Gravel chub	3	8
Flathead chub	4	0
Suckermouth minnow	2	15
Emerald shiner	31	12
Rosyface shiner	0	2
Silverband shiner	13	0
River shiner	60	0
Bigmouth shiner	0	1
Steelcolor shiner	0	36
Spotfin shiner	77	25
Red shiner	1	2
Sand shiner	1	22
Mimic shiner	0	2
Ghost shiner	0	21
Silverjaw minnow	0	3
Bullhead minnow	17	20
Bluntnose minnow	2	11
Fathead minnow	2	2
Stoneroller	0	14
River carpsucker	4	0
Silver redhorse	0	2
Shorthead redhorse	3	0
River redhorse	1	0
Channel catfish	1	0
Northern studfish	0	3
Mosquitofish	2	0
Smallmouth bass	1	1
Largemouth bass	1	3
Longear sunfish	0	22
Bluegill	1	2
White crappie	0	6
Walleye	0	1
Sauger	1	2
Slenderhead darter	2	1
Southern logperch	1	0
River darter	0	1
Greenside darter	0	2
Mud darter	0	1
Freshwater drum	3	2
Brook silverside	0	4

NOTES: [a] See Figure 29 for location of Stations M-11 and L.

Source: (021)

Rare or Endangered Aquatic Species

Two mussels reported as being found in the Meramec River are on the federal list of endangered species. These are Lampsilis higgensi and L. orbiculata orbiculata. Other mussel taxa of interest for their rarity which may occur in the study area are (021,072):

1) The Pelecypod or mussel known as spectaclecase (Cumberlandia mondanta) has been recorded in the river and within the study area; it is classified as rare throughout its range and has been proposed for federal listing as endangered (072).

2) The mussel, rock pocketbook (Arcidens confragosus), has been found in the Lower Meramec, and possibly occurs in the study area (021); its status is still undertermined (072).

3) The snuffbox (Dysnomia triquetra) occurs in the Lower Meramec and possibly in the study area (021); its status is undetermined (072).

4) The mussel, elephant's ear (Elliptio crassidens) is extremely rare in the Meramec River and may possibly occur within the study area (021,072).

5) The mussel (Leptodea leptodon), is classified as rare throughout its range (072) and has been proposed for federal endangered status. This mussel probably occurs in the Meramec River within the study area (021).

6) The hickory-nut (Obovaria olivaria) has been found in the Meramec as far downstream as Times Beach and may possibly occur in the upper portion of the study area (075); its status is undetermined (072).

7) The bullhead mussel (Plethobasus cyphus) occurs in the Lower Meramec River and may possibly be found in the upper portion of the study area (075); its status is undertermined (072).

The occurrence of rare or endangered fish species in the study area is infrequent, if not improbable. This conclusion is based on careful examination of Pflieger's descriptions of species habitat preferences and recent distribution records (084, 072). The following rare or endangered species in Missouri (072) have been known to occur within the study area: Alabama shad (Alosa alabamae); blue sucker (Cycleptus elongatus); and pallid shiner (Notropis amnis). The Alabama shad is an anadromous species that has been recorded as far upstream as the Times Beach area. The present Missouri status of this shad is rare (072). The blue sucker is classified as rare in Missouri and inhabits swift stream chutes of the Missouri and Mississippi Rivers and similar habitat in their large tributaries (072). Collection records indicate it has been found in recent years in the area of Valley Park ( ). The pallid shiner, which may be extirpated, (072) has only been found at one site in Missouri since 1946. That collection was taken in the area of Times Beach (084). The pallid shiner seems intolerant of siltation and turbidity, but the cause of its decline is unknown (084).

Certain rare or endangered fish species such as the burbot (Lota lota) and the sicklefin chub (Hybopsis meeki) could possibly stray into the Meramec River mouth from the Mississippi River. However, based on their relative scarcity and their preference for big river habitat, such migration would be improbable.

Aesthetics

Although the aesthetic value of an area depends on one's personal preference, many characteristics of the Lower Meramec River Basin would generally be regarded as aesthetically satisfying. Most of the basin is covered by forest and the lush vegetation that starts at the shoreline and extends upland provides a pleasant view along most locations of the Lower Meramec River. In spring and early summer, the wildflowers' vibrant colors are enhanced by the forests' green vegetation. Flowering trees, such as dogwood and redbud, are interspersed among taller, hardwood species. The mixed hardwood forests of oaks, hickories, and other species have an understory of smaller trees, vines, and herbaceous flora, which provide ample cover and forage for many wildlife species.

As summer ends, nights cool, and light intensity lessens, a varied and vivid fall coloration develops in the hardwood forest.

Caves are scattered throughout the Lower Meramec River Basin. In addition to the unique plant species at their entrances, the geologic features of the caves themselves are of interest to many observers.

In order to properly assess the total aesthetic value, consideration must also be given to area characteristics that are not aesthetically pleasing. Some of the detractions of the study area are: the frequent flooding of the river's flood plain caused by backwater from the Mississippi River; the degraded water quality of the river and many of its tributary creeks (001); the much diminished utilization of the river as a recreational area due to its reputation in recent years for being polluted (001); and intrusions by urbanization.

The continuing trend of development in the study area, while providing new housing units, services, and industry, reduces the acreage of forest and pastureland. The lower reaches of the Meramec River have begun to show evidence of problems typical of streams close to urban areas. Cottages and shacks along the river banks, rubbish and debris, and mining operations detract from the scenic view of forests and pastureland. Similarly, total mileage of formerly undisturbed tributary creeks is being reduced through piecemeal modifications, denuding of bank vegetation, and limited erosion and runoff control. As population increases, increased sewage generation results in further organic pollution of tributary creeks and the Meramec River.

Relatively large portions of the study area have no sewage service and must rely on septic tanks. When the ground becomes saturated (due to underlying rock strata), septic tanks fail and frequently flow through rock faults into the groundwater which feeds many area springs. As a result, many springs in the area are now somewhat polluted (001).

Pollution of certain creeks in the study area is severe (085). The entire 10-mile length of Fishpot Creek is considered to be seriously polluted. Fish kills have been a common occurrence in streams such as Fishpot and Grand Glaize Creeks.

SOCIAL ENVIRONMENT

Population Trends and Dynamics

The population of communities located within St. Louis and Jefferson Counties has grown substantially since 1890. The improved transportation network in the St. Louis metropolitan area was an important stimulus to development.

Current plans to improve transportation networks, to increase recreational land, and the expected outmigration from the urban and metropolitan areas to rural areas is projected to result in population increases in the study area (021). In 1970, the study area population was approximately 142,890 (114,140 for the St. Louis County portion and 28,750 for the Jefferson County part) (086). The population projected for 1980 is about 167,540 (131,630 in the St. Louis County portion, 35,910 in the Jefferson County portion); for 1995, the total projection is about

206,630 (158,465 in the St. Louis County portion, and 48,165 in the Jefferson County portion) (086). These projections indicate a 44.6 percent increase in the population of the study area between 1970 and 1995. The trend implied by these figures indicates the study area's total population will be 222,300 by the year 2000.

As the projected outmigration continues, a number of trends are anticipated, particularly in the Jefferson County portion. Median age should decline while the education level of the population should increase. Household size will either remain the same or will decrease slightly. No change in the racial composition of the study area is expected (021).

While Jefferson County's population increased significantly from 1930 to 1970, the urban composition of that population decreased from 44.3 percent to 16.8 percent. This trend was caused by the proliferation of unincorporated communities which are classified as rural non-farm (76.3 percent in 1970). St. Louis County had a 95.8 percent urban population and a 3.8 percent rural non-farm population in 1970.

Population and educational characteristics are shown in Table 41. Between 1940 and 1970, the median number of school years completed by basin residents over 25 years of age increased (021). The educational level of St. Louis County residents was greater than the mean for the State of Missouri, while that of Jefferson County was lower.

The projected and the 1970 income for residents of the study area is presented in Table 42. Income data, when analyzed by zone, (087) indicates that residents of most areas adjacent to the Meramec River (particularly lower elevation) had middle and low incomes; residents of the upper watersheds in the Jefferson County portion of the study area generally had middle incomes; and residents of most of the upper watersheds in the St. Louis County portion had predominantly high incomes. Incomes of study area residents in 1970, by watershed, can generally be classified as follows: middle income - Williams, Saline, Sugar, Romaine, and Pomme Creeks; high income - Kiefer, Fishpot, Grand Glaize, Mattese, Yarnell, and Fenton Creeks and all Meramec sub-watersheds (088). The total number of dwelling units (houses, apartment buildings, etc.) in the study area, by watershed, is given in Table 43.

Economics

Land - The study area has approximately 91,600 acres of land. In 1970, vacant land comprised about 59,800 acres (65 percent) and residential, commercial, and industrial land uses totaled

TABLE 41

POPULATION AND EDUCATIONAL CHARACTERISTICS
JEFFERSON AND ST. LOUIS COUNTIES, MO, 1970

Age Group	County and State	Total	Male	Female	Percent of Total Population
Under 5	Jefferson	10,562	5,440	5,122	10.0
	St. Louis	78,536	40,157	38,379	8.3
	Missouri	371,072	--	--	7.9
5 to 14	Jefferson	25,284	12,997	12,287	24.0
	St. Louis	206,545	105,253	101,292	21.7
	Missouri	919,355	--	--	19.7
15 to 24	Jefferson	16,795	8,071	8,724	16.0
	St. Louis	152,359	71,762	80,597	16.0
	Missouri	784,350	--	--	16.8
25 to 34	Jefferson	15,325	7,494	7,831	14.6
	St. Louis	124,103	59,820	64,283	13.0
	Missouri	550,324	--	--	11.8
35 to 44	Jefferson	12,883	6,525	6,358	12.2
	St. Louis	120,541	58,785	61,756	12.7
	Missouri	509,814	--	--	10.9
45 to 54	Jefferson	10,167	5,167	5,000	9.6
	St. Louis	114,051	55,838	58,213	12.0
	Missouri	518,134	--	--	11.0
55 and over	Jefferson	14,232	6,898	7,334	13.6
	St. Louis	155,218	68,222	86,996	16.3
	Missouri	1,023,452	--	--	21.9
Total	Jefferson	105,248	52,592	52,656	100.0
	St. Louis	951,353	459,837	491,516	100.0
	Missouri	4,676,501	--	--	100.0
Median Age	Jefferson	25.0	24.7	25.2	--
	St. Louis	27.9	27.0	28.7	--
	Missouri	29.4	--	--	--
Average Number of School Years Completed	Jefferson	11.1	10.9	11.2	--
	St. Louis	12.3	12.4	12.3	--
	Missouri	11.8	--	--	--

Source: (021)

TABLE 42

STUDY AREA POPULATION INCOME, 1970 AND PROJECTED

	Number of Residents[a]		
Year	Low Income[b]	Middle Income[c]	High Income[d]
1970	25,400	34,400	62,800
1980	27,200	50,900	69,200
1995	34,100	66,100	87,300

NOTES:
[a] Rounded to nearest hundred
[b] 0 - $7,999
[c] $8,000 - $11,999
[d] greater than $12,000

Source: (087)

TABLE 43

ESTIMATED NUMBER OF DWELLING UNITS BY WATERSHED BASIN, 1970[(a)]

Watershed Basin	Number of Dwelling Units
Kiefer Creek	630
Fishpot Creek	4,900
Grand Glaize Creek	9,200
Mattese Creek	6,580
Williams Creek	360
Yarnell Creek	1,080
Fenton Creek	1,115
Saline Creek	2,150
Sugar Creek	1,030
Romaine Creek	825
Pomme Creek	1,230
Meramec Sub-Areas	
3	955
4	255
5	410
6	445
7	1,105
8	980
9	2,750
10	1,075
11	540
12	500

NOTES: (a) Estimated by assigning number of dwelling units by zone to watershed boundaries.

Source: (087)

about 23,970 acres (26 percent) (087). Land use projections indicate a continued expansion of urban and residential lands with a concomitant decrease in vacant land. Commercial and industrial development will take the form of new shopping centers and industrial parks. There will be less strip development along major transportation routes (088).

Although the number of farms in the study area decreased from 1959 to 1969, the average value per farm more than doubled due to the general increase in average farm size and the increase in the per acre value of the land (089).

The St. Louis County portion of the study area contains three major industrial districts representing one-third of the county's total industrial park land (001). This portion of the study area also contains those watersheds that are most heavily urbanized (Grand Glaize Creek, 50.2 percent ; Mattese Creek, 44 percent; and Fishpot Creek, 43.1 percent) (1970 statistics).

In 1970, the total assessed valuation of the study area was approximately $300 million. The assessed valuation projected for 1975 was in excess of $500 million. The assessed valuation of the St. Louis County portion is concentrated in the Grand Glaize, Mattese, Meramec (combined sub-basins), and Fishpot watersheds. The remaining watersheds (primarily in Jefferson County) will experience increased assessed valuations as they are developed in the future. Only 33 percent of the land in the St. Louis County portion (not including Williams and Meramec sub-basin 8) is suitable for urbanization and development (001). The following watershed percentages reflect the land acreage considered to be suitable for this purpose: Yarnell, 29 percent; Fishpot, 21.9 percent; Mattese, 20 percent; Grand Glaize, 17.3 percent; Fenton 16.6 percent; and Kiefer, 11.1 percent . It is expected that the prime land will be developed for urban, industrial, and commercial purposes within the next 5 to 10 years (001). Following this period, growth should slow considerably, but industrial and commercial development in less suitable areas of other watersheds should continue at a reduced rate. Because of the greater incidence of hilly forested upland terrain in the Jefferson County portion, less land is suitable for development.

Water - A virtually unlimited supply of surface water is available to the study area from the Missouri, Mississippi and Meramec Rivers. Additional water supplies are available from bedrock and alluvial aquifers underlying the area (009). Water from these streams must receive extensive treatment before it can be used for domestic purposes and most manufacturing processes. Untreated Mississippi River water used for once-through cooling in electric power generation at Union Electric's Meramec

Power Plant is an exception. Various St. Louis County Public Water Supply Districts provide water to incorporated areas such as Arnold or to small communities such as Castlewood (Kiefer Creek watershed). Municipally owned supply systems which use wells provide service to certain areas, including the City of Valley Park (001). A major portion of the study area receives water from the South County Plant of the St. Louis County Water Company, located on the Meramec River near Fenton. Using this plant's service area as a basis for comparison, the average consumption of the residential population is 86 gallons per capita per day (gpcd). This figure includes all domestic, industrial, commercial and institutional uses, as well as losses from the system and miscellaneous uses (001). Seasonal variations in usage are shown in Figure 30.

In May, 1978, water users' costs in the St. Louis County Water Company service area were as follows:

Residential/Commercial (Rate "A")	First 1,200 ft^3/3 mo	$8.64
	Additional 3/mo	.48/ft^3
Industrial (Rate "J")	First 60,000 ft^3/mo	$174.00
	Additional/mo	.24/ft^3

The most recent rate increase for water use was 19.2 percent for inflation. The study area's water requirements will increase almost in proportion with the rate of development and urbanization. There is no indication that such future requirements cannot be easily met.

Energy - The principal forms of energy utilized in the study area are electric, natural gas, coal, and petroleum products. The major user of coal within the study area is the Meramec Power Plant, located on the Mississippi River. Most petroleum products used in the area are consumed as fuel for gasoline-powered vehicles. The type of energy used, and the cost of each, vary and will be dependent upon supply and demand and continued availability.

Two companies provide natural gas service to the study area. The Laclede Gas Company serves the St. Louis County portion and the Midwest Missouri Natural Gas Company serves the Jefferson County portion. Natural gas is supplied to these companies through the Mississippi River Transmission Corporation. The 1977 natural gas rates are as follows:

Residential:	$0.19/100,000 Btu
Industrial: (small to moderate size)	$0.137/100,000 Btu
Large industrial:	$0.119/100,000 Btu

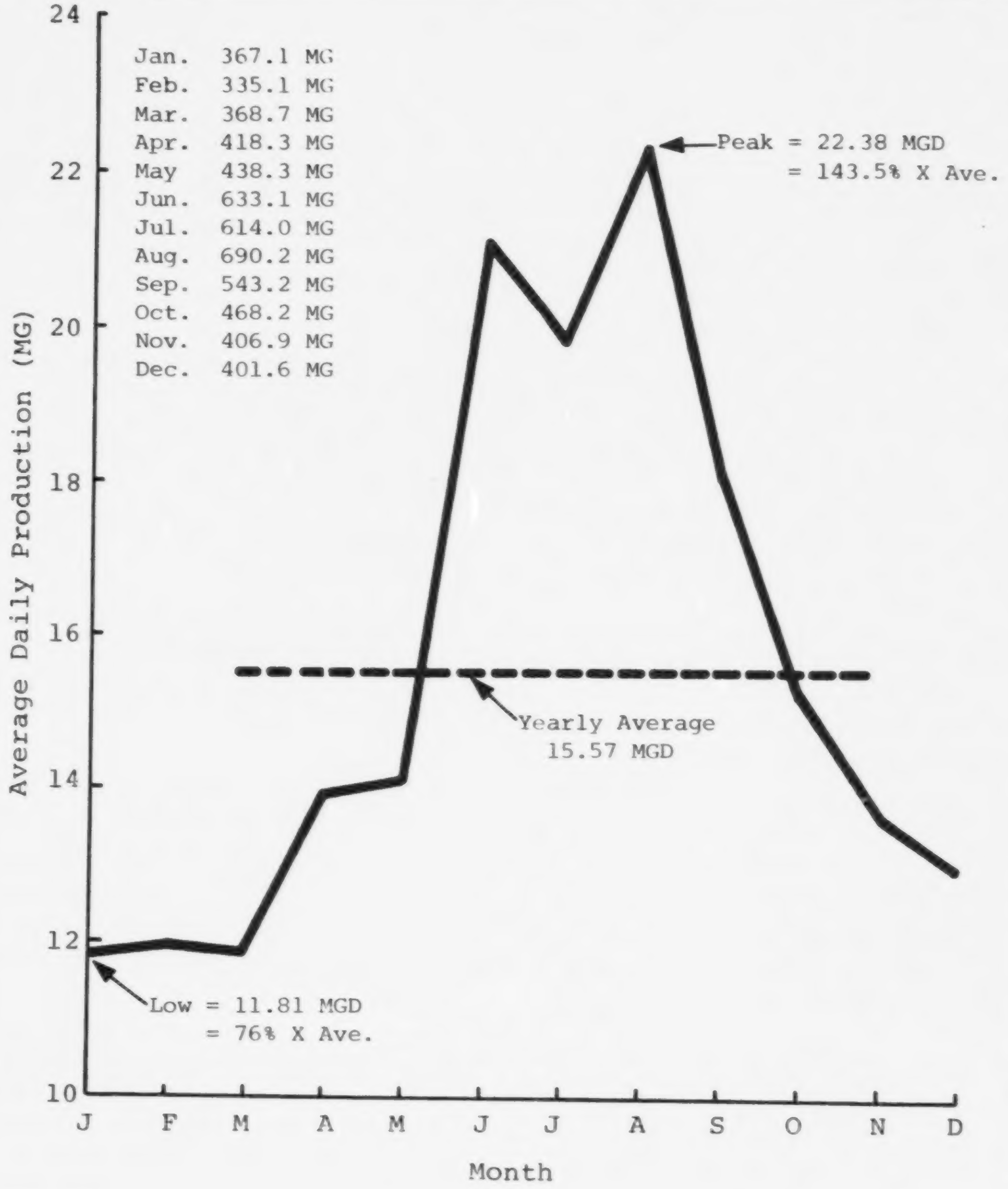


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FIGURE 30

1971 PUMPAGE RECORDS SOUTH COUNTY PLANT
ST. LOUIS COUNTY WATER COMPANY

Source: (001)

The most recent rate increase was 8 percent in 1974.

Electricity is supplied to the study area by Union Electric Company power plants, including the Meramec, which is located within the study area, Labadie, and Rush Island plants. Current electricity costs in the study area are presented in Table A15 of Appendix A.

Cost increases caused by monetary inflation, increased prices of coal, and plant construction or purchases of new equipment to meet energy needs have occurred almost annually. Plans to add gas turbine units at the Meramec Plant to supply power during periods of peak need will not alter the existing requirements for cooling water.

Extracted Minerals - Mineral resources of the Lower Meramec River Basin include sand and gravel, limestone, shale and fire clay. The minerals or mineral products produced in order of value are cement, stone, sand and gravel, and clays (089). Construction, portland cement concrete and road materials have been the primary markets for sand and gravel. The St. Louis area production of these materials from 1962 to 1967 was higher than any other area of the state (021). The St. Louis metropolitan area is a major source of stone production. Stone produced in the St. Louis area accounted for about 25 percent of the total annual value of mineral production in Missouri since 1960.

In 1969, the value of total mineral production in St. Louis County was $32,923,000. The value of total mineral production in Jefferson County is not known (021). Continued growth of the area's mineral industry is expected to accompany the projected urban sprawl (090).

CHAPTER 4

ALTERNATIVES

INTRODUCTION

This chapter contains a comparison of alternative methods for the collection, transmission, and treatment of wastewaters in the project area and disposal of the treatment by-products. The alternatives are discussed in the following order: 1) general treatment options, such as regional systems versus individual home treatment, are assessed to determine their feasibility; and 2) specific plans to accomplish the desired improvements under the most viable option are described.

Both general and specific alternatives are subject to environmental, economic and engineering constraints, as well as legal and other regulatory requirements. In addition, existing facilities and the historic background of the study area must be considered in reviewing treatment options.

CONSTRAINTS AND ASSUMPTIONS

Regulatory constraints that govern the development of wastewater treatment alternatives for the study area include the Missouri Clean Water Commission's classification of streams and effluent guidelines. The Meramec River in the study area is classified as a primary contact stream, which means that the water quality must be suitable for water contact recreation and use as a potable water supply (091). These water quality requirements are relatively stringent and discharges from municipal waste treatment plants would require tertiary treatment to comply with these standards. Published standards of the Missouri Division of Health require the elimination of discharges upstream from the potable water intake structures on the Meramec River. This constraint also limits development of treatment options in the study area. It was assumed that these restrictions will not be waived for the present project.

Missouri Effluent Guidelines (092) classify many other streams in the study area as "losing streams" because they contribute a significant proportion of their surface water to groundwater aquifers. The discharge of pollutants to these streams is not permitted, except for thermal additions specified in the standards.

Capital facility costs will be handled on a "cost-sharing" basis; the federal, state, and local shares will be 75, 15, and

10 percent, respectively. Costs of operation and maintenance would be borne locally. Economic constraints to alternatives selection also include the funding requirements of local, state, and federal agencies. For example, existing wastewater facilities in many parts of the study area are privately owned and operated. It is doubtful that a plan for the continued operation and upgrading of these facilities under present ownership, would receive financial support under PL 92-500. Likewise, limitations on funds available will probably preclude the simultaneous implementation of all portions of any areawide plan; priority-based implementation plans to complete the project in several phases will probably be needed.

Constraints on alternative selection also include the physical characteristics of the study area. For example, the soil types and topography in much of the basin limit the effectiveness of individual home treatment. Other environmental constraints have been presented in Chapter 2 of this report.

Past planning efforts by the East-West Gateway Coordinating Council, St. Louis Metropolitan Sewer District and other local and state agencies have resulted in proposals that would significantly affect the development and selection of project alternatives. For example, proposed land use plans and the 303 Water Quality Management Basin Plan (058) must be considered in the alternative analysis. In addition, municipalities within the study area have developed land use plans that could affect site selection for any proposed facilities. To assure the compatibility of the 201 Plan with the numerous existing plans and ordinances, land use projections used in the 201 Plan were developed in cooperation with the East-West Gateway Coordinating Council. The Council, in its role as A-95 review agency and central clearing house for the St. Louis Standard Metropolitan Statistical Area, was in a position to carry out the compilation and analysis necessary to coordinate these plans. In another regional planning effort, the St. Louis County Water Pollution Control Study, Phase 1 - Areas Tributary to the Meramec River (001), seven alternative plans for the study area were thoroughly analyzed, exclusive of the Williams, Saline, and Romaine Creek Basins, the Jefferson County portion of the Pomme Creek Basin, and the area draining to the Mississippi designated Meramec Subarea VIII. This analysis, funded through a planning grant by the USEPA, became the primary input for 201 Facilities Planning in most of the study area. The seven alternative plans developed in the analysis are described in a subsequent section of this chapter.

An ongoing planning program of particular significance to this 201 Study is the 208 Areawide Waste Treatment Management Study being conducted by the East-West Gateway Coordinating Council.

The overriding goal of this study, which is being performed under Section 208 of Public Law 92-500, is "to secure and maintain the waters of a given area (in this case, Franklin, Jefferson, St. Louis, and St. Charles Counties and the City of St. Louis) in such a chemical, physical, and biological condition that these waters will not create a nuisance or be harmful, detrimental, or injurious to public health, safety, or welfare" (093). A 208 Plan can attain this goal through prevention, abatement, and control of water pollution. The 201 Facilities Plan which is the subject of this EIS functions within the 208 plan by designating facilities in a part of the 208 area which will aid in attaining the aforementioned 208 goal.

DISCUSSION OF ALTERNATIVE APPROACHES TO WASTEWATER MANAGEMENT

Since much of the study area is unsewered, a number of alternative treatment system plans could be implemented without undue loss of previous investments. These alternatives are described in this section. Their feasibility is evaluated in subsequent sections.

Flow Reduction

One wastewater management tool is the reduction of total wastewater flow in a given area. The USEPA has recognized four major techniques for reducing total flow of sewage in an areawide waste management system and considers them essential to achieving optimal treatment (094). The first is the reduction of infiltration and inflow into the collection system, a pre-grant condition stated in Section 201 (g) (3) of PL 92-500. A second flow reduction measure involves water conservation at the household level through commercial water saving devices such as improved shower heads, toilets, faucets, etc. Rate-use pricing adjustments and consumer education (the third and fourth flow reduction measures) could significantly reduce water usage and therefore reduce wastewater flows. A public education program aimed at changing attitudes toward water use and conservation could be a most significant flow reduction measure (095).

Individual Home Sewage Treatment

The thin, porous soils that characterize the uplands and slopes of the study area and the near-surface bedrock conditions, especially in the western portion of the study area, make standard individual home treatment systems an environmentally acceptable alternative only in very low density areas. Individual systems could be designed to achieve better treatment, but the chance of groundwater pollution, the difficulty in monitoring and regulating the efficiency of such units, the problem of multiple discharges, and the potential for growth in each subwatershed must be analyzed for each area.

As a general rule, the study area is not geophysically capable of handling even moderate inputs of wastewater from individual home systems without creating unacceptable groundwater pollution (such as phosphates and fecal coliforms) which could enter surface waterways. Subsurface water quality is presently degraded in the upper portion of the study area, allegedly from septic tank discharges (001). Missouri Effluent Guidelines forbid discharges into "losing streams" and cite Grand Glaize and Fishpot Creeks as potentially hazardous areas due to discharge of domestic effluents. The _Load Allocation Study of the Lower Meramec River Basin_ (049) recommends that severe restrictions be placed on allowing additional septic systems in the study area as an immediate means to curtail further degradation of the basin water resources.

Collector and Interceptor Sewers

The private sewer companies operating in most of the heavily populated regions of the study area and those northeastern sections already under St. Louis MSD jurisdiction have various wastewater collection and treatment systems. The study area is divided by the dissected topography of the region into district subareas or subwatersheds with partial collection systems that vary in capacity and extent. Each subarea has been evaluated for collection systems that: 1) would be compatible with areawide collection and treatment, 2) would utilize as much as possible existing facilities and sewerage presently operated by private sewer companies or the St. Louis MSD, 3) would serve those areas with population densities that require areawide treatment to protect water quality, and 4) would still remain economically feasible.

Regional Wastewater Management

Another general alternative for wastewater treatment in the Lower Meramec Basin is regional wastewater management. In the _St. Louis County Water Pollution Control Study, Phase 1 - Areas Tributary to the Meramec River_ (001), seven regional plans for the St. Louis County portion of the study area were developed and analyzed. These plans contain collection and treatment alternatives that could be easily adapted to include the Jefferson County portion of the study area.

The location, volume and characteristics of wastewater discharges, their reuse potential and sludge generation volume are, in some cases, very dependent upon the specific plans chosen to provide regional wastewater management. This dependence is clearly illustrated by the following example: wastewater discharged to the Meramec will require a higher level of treatment than wastewater discharged to the Mississippi because of 1) differences in stream classifications (related to use and ability to assimilate pollutants), and 2) potential threats to potable water supplies from the Meramec. The cost of attaining these levels will be significantly higher, so that economic factors must be considered in the choice of an alternative. These factors will therefore be described during the discussion of these options, which will include discharge of wastewater to the Meramec and/or Mississippi River, land application, and reuse. Sludge disposal methods that will be considered are land application, land disposal, incineration, lagoons, and transportation to the LeMay plant for disposal in their system. Specific treatment methods that will be evaluated after the alternative plans are screened include activated sludge (by air or pure oxygen), physical-chemical, trickling filters, and rotating biological discs.

Project Phasing

Upon selection of an alternative action, implementation will have to be phased due to the limited capital available for construction and the environmental importance of certain subsystems. For instance, Grand Glaize, Fishpot and Mattese Creek tributary watersheds have generally higher average BOD_5, COD, NH_3-N, and PO_4 loadings than the other creeks studied in the Load Allocation Study (049). These three streams generally contribute 70 percent of the average surface water flow into the Meramec at certain periods (October to November 1973 survey) (049). High pollution loads from Grand Glaize and Fishpot coincide with the relative density of urban development in these areas (001).

These three areas comprise approximately 22,200 acres (24 percent of the study area). They contained 57 percent of the 1970 study area population and, according to EWGCC estimates, will support 52 percent of the projected population in the year 2000. The confluences of the streams with the Meramec occur upstream from potable water intakes. Therefore, these three subwatersheds are prime units for initial wastewater management, while less populated areas, because their current impact on water quality is less significant, are less critical.

SCREENING OF ALTERNATIVE APPROACHES TO WASTEWATER MANAGEMENT

The diverse geographic locations and density of the study area's residential development, when analyzed in light of projected population growth and land use changes associated with this growth, reveal a complex pattern that requires detailed planning at the subwatershed level. However, assessment of the general options available will result in an overall planning directive that will provide areawide objectives from which specific subplans can be developed. The general alternatives discussed above are described in this section as they might be utilized within the study area.

Flow Reduction

Flow reduction cannot be considered a viable option for wastewater management in this study. Whereas measures to reduce excessive flow would both conserve water and optimize treatment, they would not of themselves meet project objectives, i.e., elimination of all discharges into "losing streams", upgrading of inadequate facilities, and elimination of discharges upstream from potable water intakes.

Public Law 92-500, the Federal Water Pollution Control Act of 1972, which provides federal funding for the planning and construction of areawide treatment works, stipulates that "the applicant show ... each sewer collection system discharging into such treatment works is not subject to excessive infiltration." Grants are not permitted unless infiltration/inflow (I/I) is reduced when found to be excessive. Thus, flow reduction measures, especially the elimination of excessive infiltration and inflow, will be included as a part of any viable plan option.

An infiltration/inflow (I/I) analysis of project watersheds was performed as a part of the 201 Facilities Plan. The accuracy of the analysis was limited by the extremely low rainfall in 1976 (when the analysis was carried out) and the scope of the analysis was limited by jurisdictional problems, specifically the refusal of the St. Louis County and Fenton sewer companies to permit inspection of their systems. The findings of the analysis (reported by watershed in the 201 Plan) indicate that sewerage systems in many watersheds in the St. Louis County portion of the study area are subject to excessive infiltration/inflow, and that it would be most cost-effective to control 60 to 80 percent of this excess, depending on the system. Sewerage in Jefferson County is relatively new and no problems with excessive infiltration/inflow have been reported.

The correction of I/I problems would significantly decrease the costs of a new system. Total design capacities could be reduced which would result in lower capital costs. Operation and maintenance costs, all of which would be borne locally, could be decreased.

Due to the above-listed factors limiting the usefulness of the I/I analysis, the 201 Plan recommends that a Sewer System Evaluation Survey be carried out in areas where I/I has been found to be or is believed to be excessive. This survey would make it possible to develop a sewer rehabilitation program which focuses on areas where I/I is so excessive that treatment costs (for the excess) will exceed the costs of sewer rehabilitation. This program would result in the economic benefits discussed above.

Individual Home Treatment

Individual home treatment is undesirable in the project area where population densities are such that filtration and wastewater renovation cannot occur due to overloading of the removal system. The precise density at which pollution problems occur is difficult to determine due to differences in groundwater flow patterns, soil types, etc. However, the soils in the study area are generally poor substrates for septic systems and it has been recommended that additional permits be restricted (049). The factors limiting the suitability of various soil types in the project area for septic tank tile fields include seasonally high water tables in low-lying areas, low percolation rates in many upland soils, and steep slopes and shallow depths to bedrock in many upper reaches of tributaries. Therefore, utilization of standard individual home systems as a viable alternative is considered environmentally unacceptable and should be allowed only where it is not economically feasible to provide collection systems. Where individual units exist or are necessary they could be designed to achieve removal (e.g., sand filters before discharge) above standard levels.

Guidelines utilized in the Basin study (058) assumed that incorporated communities of over 250 and unincorporated areas with a population density of over 1500 per square mile could financially support a central sewage system. Whether these criteria will protect water quality in the study area is unknown. Each individual case will have to be evaluated separately and the decision to permit further individual systems based on economic and environmental considerations. It is impossible to consider each separate case in this evaluation.

Regional Wastewater Management

The final general alternative is regional collection and treatment of wastewaters. In view of the water quality problems that exist in the basin, projected growth and development rates, and the study area's physical characteristics, some type of areawide system is recommended as the sole environmentally acceptable alternative. Collection plans should include all populated areas and, eventually, every domestic discharge in the study area where the potential for environmental damage exists.

PRELIMINARY SCREENING OF ALTERNATIVE WASTEWATER MANAGEMENT SYSTEMS

In the St. Louis County Water Pollution Control Study (001), seven physical plan alternatives were developed to provide the 201 Facilities Planning area with areawide wastewater treatment. A brief description of these plans and the rationale behind their ultimate disposition follows.

Plan A

Proposal - Construct separate collection systems for each watershed and provide treatment at new locations in Basin.

Evaluation - Necessity for pumping facilities is minimized. Treatment would be tertiary at all plants on Meramec River, secondary level treatment for those on Mississippi. The effluent characteristics required for discharge under these alternatives are as follows (093):

	Secondary Treatment (Discharge to Mississippi)	Tertiary Treatment (Discharge to Meramec)
Biochemical Oxygen Demand	30 mg/l	10 mg/l
Suspended Solids	30 mg/l	12 mg/l
Total (Kjeldahl) Nitrogen	No Restriction	1.5 mg/l
Phosphorus	No Restriction	1.0 mg/l
Disinfection	Not Required	Required

Process schemes which would treat effluents to these levels include:

Secondary

Raw Waste → Preliminary Treatment → Primary Settling → Conventional Activated Sludge → Discharge

Tertiary

Raw Waste → Preliminary Treatment → Primary Settling → High-rate Activated Sludge with Alum →

→ Bio-nitrification → Mixed Media Filtration → Disinfection → Discharge

As illustrated by these schemes, treating wastewater to a tertiary level involves considerably more material, energy and expense. Disadvantages include several discharges above potable water intakes on Meramec River and a less reliable service due to multiple plant operation. This plan is feasible within project constraints.

Plan B

Proposal - Construct separate collection systems for each watershed and treat all wastewater at combined facility located south of City of Fenton.

Evaluation - Discharge into Meramec above St. Louis County Water Company intake. Effluent must be treated to tertiary level. Location of plant requires delegation of operation responsibility to less experienced agency. Feasibility considered low due to economics and high potential for contamination of water supplies if an accident should occur.

Plan C

Proposal - Same as B. Plant located in St. Louis County.

Evaluation - Same objections as B.

Plan D

Proposal - Collection same as B; a lined tunnel would be constructed to convey wastewater from Fenton along Gravois Road to the River Des Peres foul water sewer and thus to the LeMay Plant for treatment.

Evaluation - Cost significantly greater than Plan E, which has same basic concept.

Plan E

Proposal - Same as D, with alignment of tunnel from east of City of Kirkwood to Gravois Road and on to the LeMay Plant This alignment would require pumping to tunnel.

Evaluation - Plan E is more economical than Plan D, but involves considerably higher construction costs than Plan C. However, operating costs reduce this difference significantly. The tunnel to LeMay plant is inflexible due to "fixed" facilities at the treatment end. The plan may not accommodate growth projected for the study area, and the River Des Peres foul water sewer is known to surcharge untreated waste during high flows, thus creating undesirable environmental impacts.

Plan F

Proposal - Direct flow from the upper watershed to the LeMay Plant. Lower basin wastewater to be treated by private sewer company in Mattese Creek area.

Evaluation - Feasibility of private sewer company plan questionable on grounds of system reliability. Plan F would split planning area and reduce control of treatment facility by the public.

Plan G

Proposal - Construct collection systems for each watershed and a major trunk line from the upper reach of study area to new treatment plant sited below Mattese Creek on the Meramec River. Discharge effluent into Mississippi River via a pipeline.

Evaluation - Plan G would meet all existing water quality and discharge regulations for the study area and permit discharge of secondary effluent into the Mississippi. One plant would reduce operating costs and, by retaining the entire system in the basin, planning flexibility and project control would be retained. Plan G's flexibility would allow expansion of service to currently sparsely populated watersheds in Jefferson County as collection becomes necessary.

Of these plans, "C" and "E" were considered most viable until it became apparent that the Mattese Creek area, which was originally excluded from the planning area, would not be able to provide adequate treatment under the economic restrictions placed upon the private service company in that watershed. When the Mattese Creek area is included in the alternative analysis, the need for a flexible, independent and regional system becomes apparent.

In view of the water quality and effluent guideline restrictions that must be considered, Plan G should provide the most cost effective, flexible, regional plan of all the alternatives considered. Plan A would also provide adequate treatment although at multiple locations, and remains a feasible alternative as well. Evaluation of environmental impacts will focus on these two general alternatives, as well as the No Action option. Plan "G" will be called the regional alternative and Plan "A" the subregional alternative. The "No Action" alternative is unacceptable from an environmental standpoint. However, as required by law, it will be considered and evaluated in subsequent sections as a basis of comparison.

SCREENING OF ALTERNATIVE WASTEWATER TREATMENT AND SLUDGE PROCESSING AND DISPOSAL APPROACHES

Wastewater Treatment Approaches

Three general types of waste treatment were considered for the study area: land application of wastes, treatment and reuse of effluent, and treatment and discharge to receiving waters. These approaches are discussed in this section, along with their applicability to the study area.

Land Application of Wastes - This method is usually implemented by one of three means: irrigation, overland flow, or infiltration/percolation. Irrigation is the application of wastewater to the land to sustain plant growth. The method is widely practiced and reliable, but has several important disadvantages for use in the study area. Chief among these are the large acreage of suitable land required (9.5 to 37.5 square miles for this project by the year 2000) (096), the large storage capacity needed for holding the effluent during winter months, and the potential for groundwater pollution when applied in areas with geophysical characteristics such as those in the study area. Overland flow is basically a type of biological treatment in which wastewater is applied to gently sloping, relatively impervious soil planted with vegetation. Treatment occurs as the wastes contact biota in the ground cover. The major limitations on the use of overland flow in the study area are the effects of climatic changes on treatment efficiency, the requirement for a large tract of land (3 to 9 square miles by 2000) (096), and the lack of adequate testing data for use in establishing loading rates and nutrient removal effects. Infiltration/percolation involves application of wastewaters to the land so that they may infiltrate the soil surface and percolate through the soil pores. The major drawback to this type of treatment in the study area is the high potential for groundwater pollution. The land that would be required for this type of treatment by the year 2000 is estimated at between .15 and 4.0 square miles, depending on the type of soil involved (096).

The geophysical characteristics of the study area, the great expense which would be involved in purchasing necessary land, and the lack of sufficiently large tracts of land, even if such costs could be borne, effectively eliminate land application of wastes from further consideration as a viable treatment technique.

Treatment and Reuse of Effluent - This technique is not a treatment alternative; however, it affects the disposition of effluent and thus is included in this section. Treated municipal wastewater has generally been used for industrial cooling and process water supply, for groundwater recharge, and for development of arid land. Since the supply of both surface and groundwater is plentiful in the study area, the latter two uses would not be practical. Also, in view of this plentiful water supply, the high cost of treatment to the degree necessary for use in industry in the study area could not be justified. This is illustrated by the fact that Union Electric Company was approached as a possible user of project effluent but rejected the plan for the reasons stated above.

Treatment and Discharge to Receiving Waters - This method is the remaining alternative treatment measure considered. Based on a review of other alternatives and an appreciation of the availability of nearby potential receiving streams, this approach is regarded as the most feasible for the study area. Several alternative treatment methods are included in this approach that might be termed "process alternatives". Twelve of these methods were considered for application to this project (096):

1) Physical/chemical treatment system
2) Aerated lagoon
3) Bio-oxidation tower (trickling filter with synthetic media)
4) Rotating biological contactor

5) Air activated sludge modifications

   a) Conventional with tapered aeration
   b) Step aeration
   c) Complete mix
   d) Contact stabilization
   e) High rate
   f) Kraus process
   g) Extended aeration

6) Pure oxygen activated sludge

All of these process alternatives have been evaluated in terms of their ability to treat wastewater to a level acceptable for discharge to the Mississippi River (i.e., "secondary" treatment), as would be required under a regional plan. Further tertiary treatment would be required for discharge to the Meramec. This additional treatment would be effected by the addition of nitrification (aeration), filtration, phosphorous removal, and disinfection processes to the alternative selected.

Detailed descriptions of these methods are readily available in manuals and textbooks on wastewater treatment and will not be reiterated here. Instead, the results of the analysis used to screen the methods conducted during the 201 planning process (096) will be described.

The twelve processes were subjected to a preliminary screening which ranked them in terms of economic, environmental, and practical constraints. Based on a scale from 1 to 10, each constraint was assigned a "weighting factor" indicating its significance to the treatment facility involved in this project. These constraints and the weighing factors applied to them are as follows:

1) Capital cost - the initial cost of property, structures, equipment, etc., involved in construction of the system - 8 points

2) Operation and maintenance cost - the continuing cost of labor, equipment, etc., required to properly operate the system - 6 points

3) Resources cost - the continuing cost of the energy and chemicals necessary to properly operate the system - 7 points

4) Performance capability - the generally recognized, quantitative level of BOD and suspended solids removals achievable by the system - 10 points

5) Reliability - the ability of the system to maintain its performance capability, consistently, even in the event of changing conditions - 10 points

These four alternatives were subjected to further, more detailed analysis with the resulting conclusion that any of the four would be acceptable as a process alternative and that the ultimate selection would be based on factors such as economics and the sludge disposal method selected. Since all four alternatives are adaptations of the same basic process, all four would produce effluents of similar characteristics and comparable quantities of sludge, and all would require similar amounts of land for process equipment, they are considered to have "equal" environmental effects and will be considered together as the "activated sludge process" in subsequent analysis.

Sludge Processing and Disposal Alternatives

Processing - During the 201 Facilities Planning process, sludge processing alternatives were classified into six basic categories: thickening, stabilization, conditioning, dewatering, heat drying, and reduction. Within each of these categories, several alternative processes were analyzed through the use of matrices similar to those used above in evaluating wastewater treatment.

Thickening: Three basic thickening processes were investigated: gravity, dissolved air flotation, and centrifugation. On the basis of the matrix evaluation, efficiency of operation, energy requirements, and numerous technical factors, the processes recommended were gravity thickening of primary sludge and dissolved air floatation thickening of secondary. No significant difference in enviromental effects among these processes is foreseen.

Stabilization: Six sludge stabilization processes were evaluated in a manner similar to that applied above. These six included chlorine oxidation, lime treatment, aerobic digestion, anaerobic digestion, composting, and heat treatment. The matrix analysis, coupled with an analysis of each method's compatibility with the overall treatment system concept being developed, led to the recommendation of anaerobic digestion as the preferred alternative.

Conditioning: Three sludge conditioning processes were evaluated on the basis of degree of conditioning desired, energy requirements, and sludge characteristics. These three were heat treatment, elutriation, and chemical treatment. Heat treatment was eliminated on the basis of complexity of operation, significant energy consumption, and adverse effects on air quality. Elutriation (washing) was eliminated due to the basic incompatibility of its products with the overall system being developed. Chemical conditioning during several stages of the sludge processing was recommended on the basis of lower capital costs, simplicity and flexibility of operation, lower energy consumption and absence of significant deleterious effects.

Dewatering: Dewatering processes were eliminated from consideration due to difficulties in transporting and spreading dewatered sludge in the lagoon system which was recommended for sludge disposal.

Heat Drying: Heat drying may be considered as either a sludge treatment or a sludge reduction process. Its principal advantages are reduction of volume and destruction of pathogenic organisms. Its principal disadvantages are energy consumption and potential adverse effects on air quality. In the context of the lagoon disposal recommended for the project, heat drying would not be applicable. However, if a market could be found for the heat-treated sludge and if economic feasibility could be demonstrated at the small scale involved, the method would certainly merit further consideration.

Reduction: The three sludge reduction methods considered (pyrolysis, incineration, and wet-air oxidation) are all complex and expensive and were not felt to be justified in consideration of the relatively small sludge amounts anticipated at the Meramec project.

Disposal - Five methods of final sludge disposal were studied: land application, land reclamation, power generation, sanitary landfilling, and lagooning.

Land Application: This method was eliminated due to high transportation costs and lack of an identifiable market for the sludge.

Land Reclamation: This method was eliminated because of political/jurisdictional problems in obtaining sites (most suitable nearby sites are in Illinois), potential groundwater pollution, and potential build-up of toxic materials in the soil.

Power Generation: Utilities in the project area have not been receptive to suggestions of a program to generate power through the use of sludge or sludge combined with other fuels. Thus, this option appears infeasible at this time.

Sanitary Landfilling: All recent solid waste studies in the St. Louis area indicate that, while numerous landfill operations exist in the vicinity of the project, many are approaching capacity or are not being properly operated and that landfilling operations in general should gradually be phased out of the solid waste program. Thus, use of sanitary landfills for ultimate disposal of sludge does not appear to be a prudent alternative.

Lagooning: Lagooning is really an interim solution in that, while the lagoons may be designed for long-term storage, they must eventually reach capacity and be cleaned out or abandoned. However, in the absence of a suitable alternative and in consideration of the fact that lagooning operations in the St. Louis area have been highly successful, lagooning seems to remain the most feasible disposal alternative.

CONCLUSIONS

After application of the screening processes discussed in this chapter, either a subregional or a fully regional wastewater treatment system is recommended. Environmental impacts associated with these two systems will be examined in Chapter 5 and compared with impacts under the no action option. The wastewater treatment approach analyzed for both action alternatives will be treatment and discharge to receiving waters: the Meramec River under the subregional system and the Mississippi under the regional system. Secondary treatment will be analyzed for the regional system and tertiary for the subregional. Under both systems, sludge disposal will be accomplished by on-site lagooning.

Two alternative conveyance systems will be analyzed under the regional plan. The potential impacts of these "trunk-lines", especially construction-related impacts, cannot be suitably addressed through screening of the type described in this chapter. These alternatives will be subjected to in-depth analysis in Chapter 5 of this report. The three alternative systems described above are illustrated in Figures 31, 32 and 33.

Table 45 presents a rough cost comparison of the three alternative sewer systems considered in Chapter 5 (including the no action plan). This table is included for the purpose of comparing the general magnitude of these costs and is not intended to present a summation of accurate engineering cost estimates. The costs presented are derived from the September, 1977 and January, 1978 draft reports for this project (096, 097, 098) and include only the major elements involved in each alternative. Elements not included in these costs are:

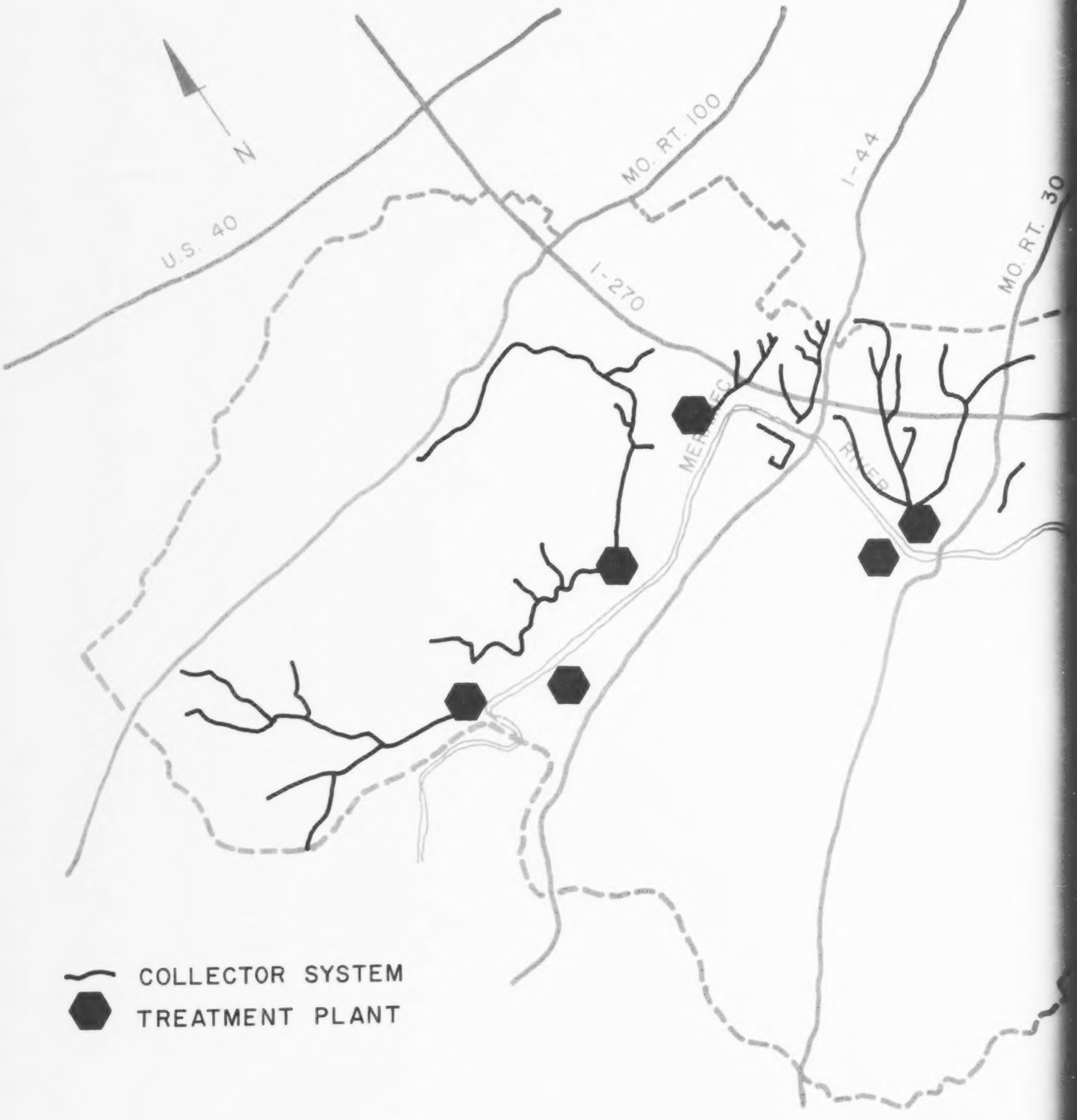
1) Engineering costs and construction contingencies

2) Real estate and easement costs

3) Flood protection costs

4) Operation and maintenance costs for the subwatershed collection systems

5) Escalation costs involved in implementing a system phased over a number of years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U.S. 40
MO. RT. 100
I-270
I-44
MO. RT. 30
MERAMEC
RIVER
COLLECTOR SYSTEM
TREATMENT PLANT

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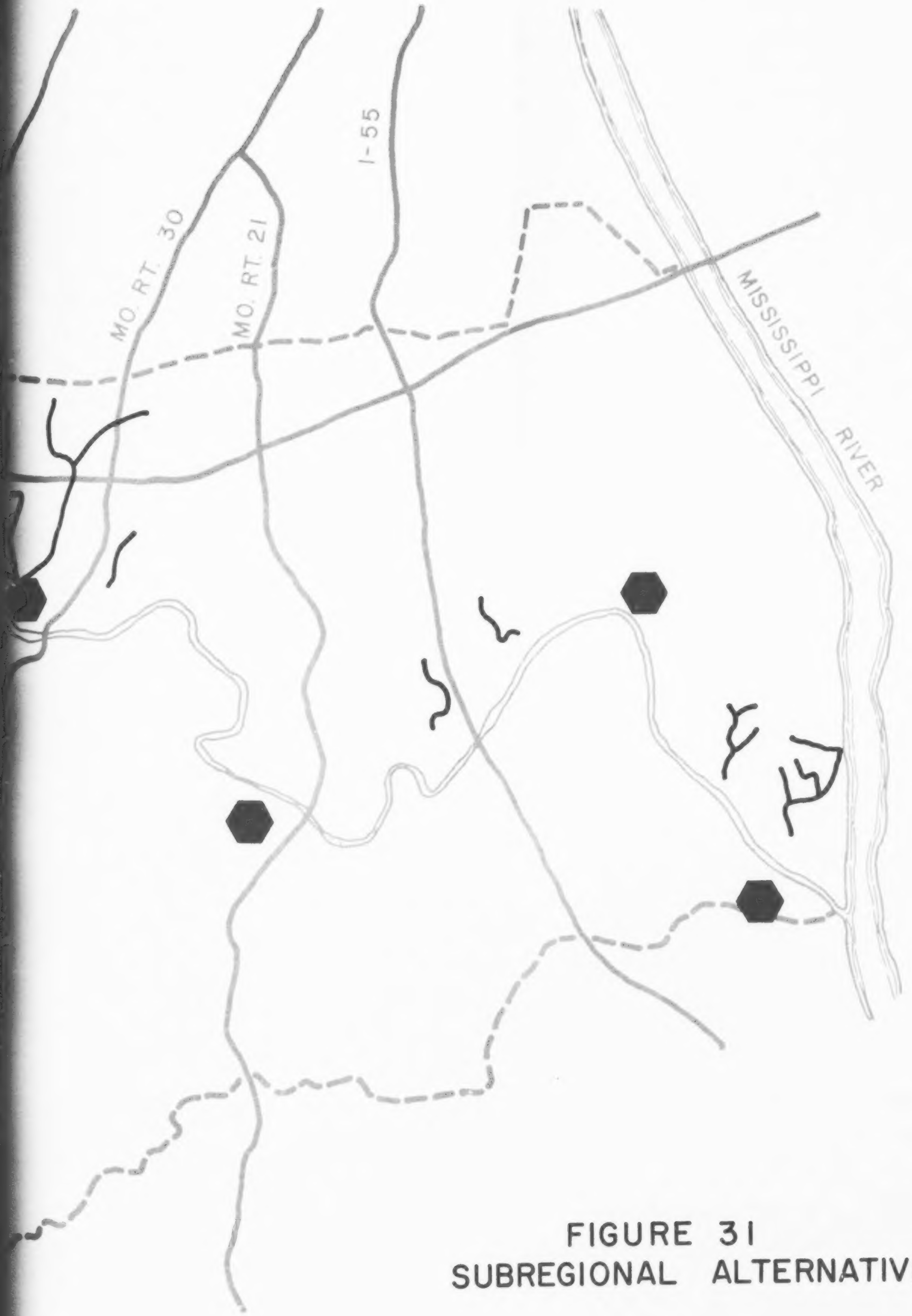
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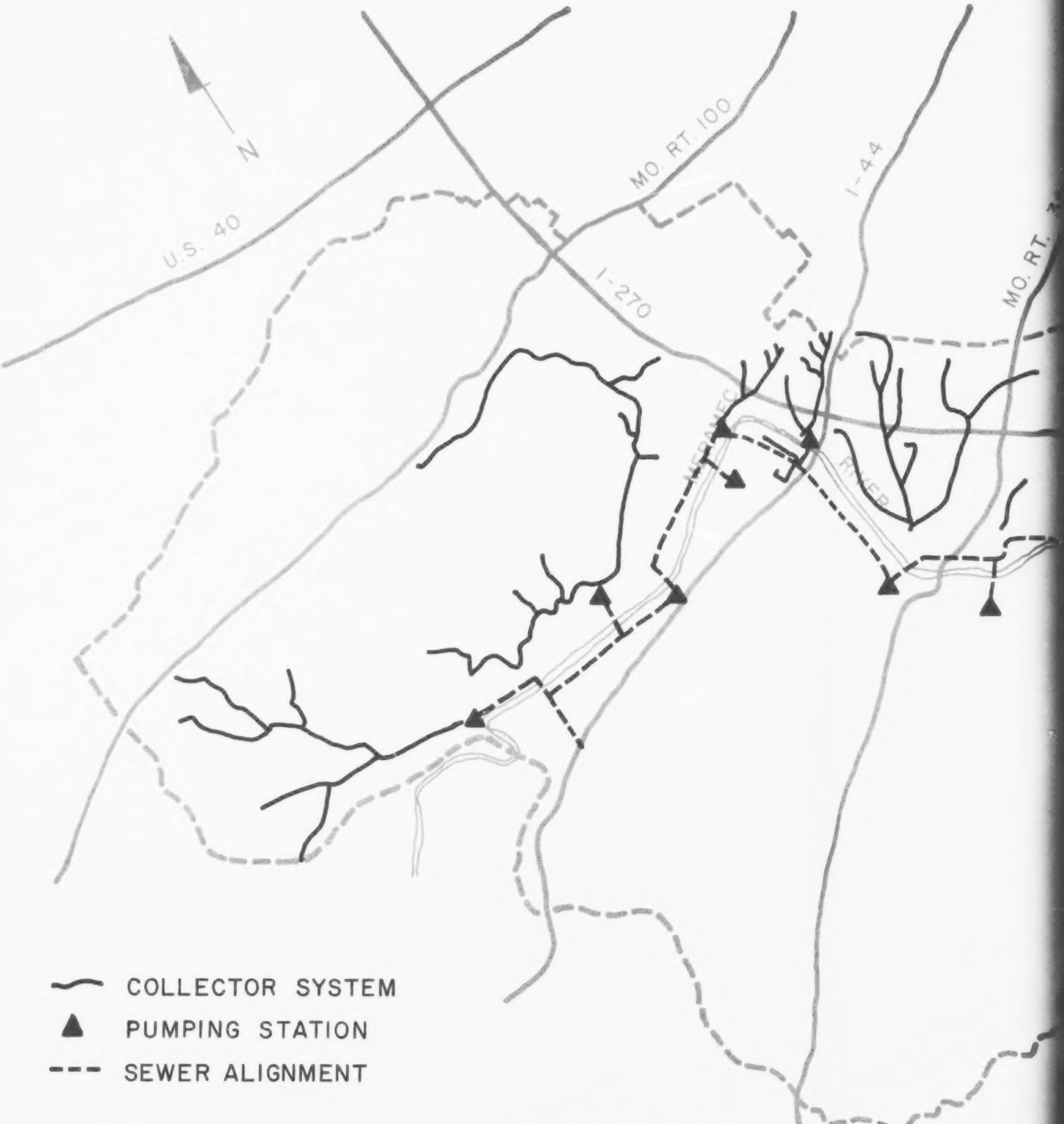
MISSISSIPPI RIVER

FIGURE 31
SUBREGIONAL ALTERNATIVE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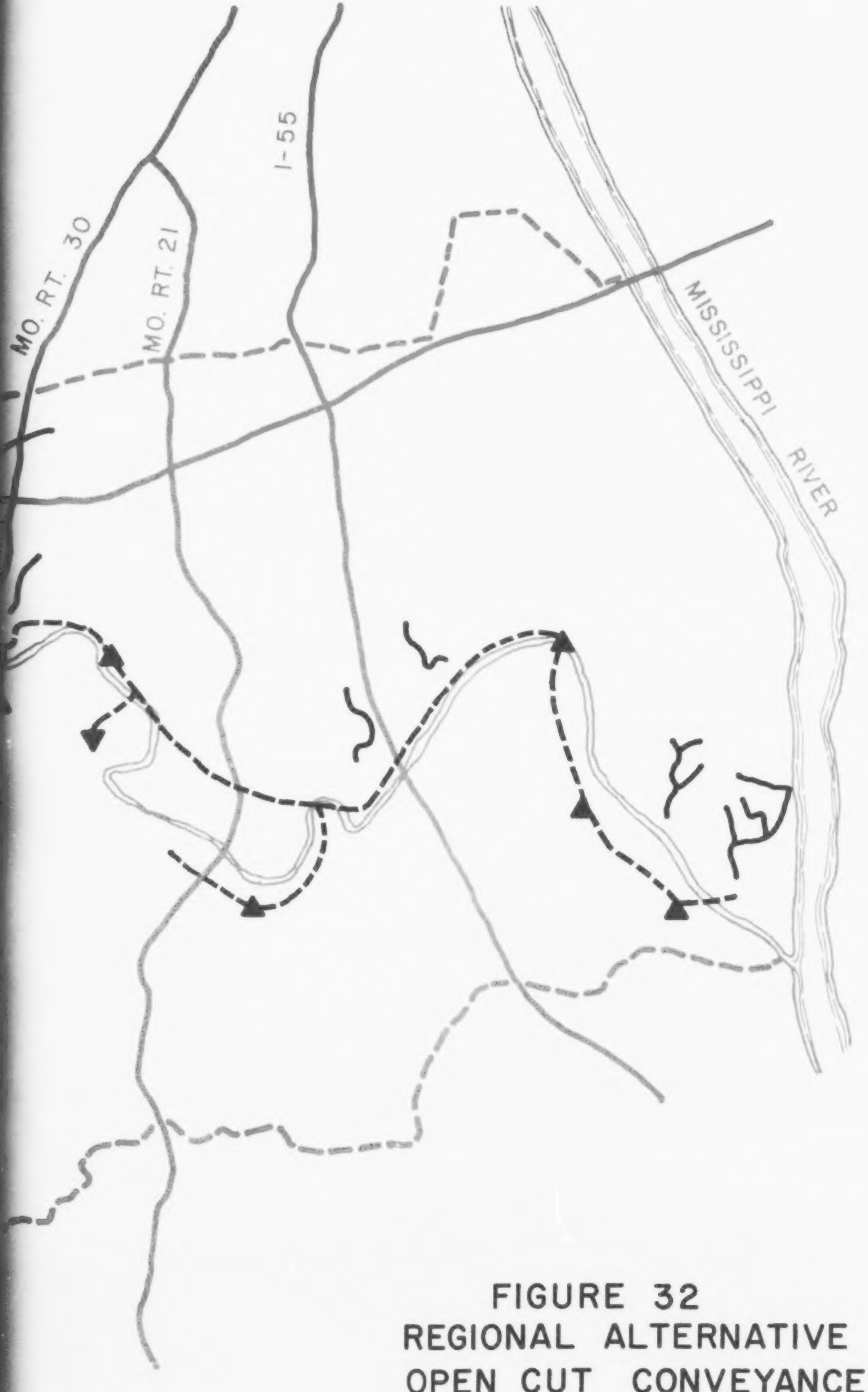
SEWER ALIGNMENT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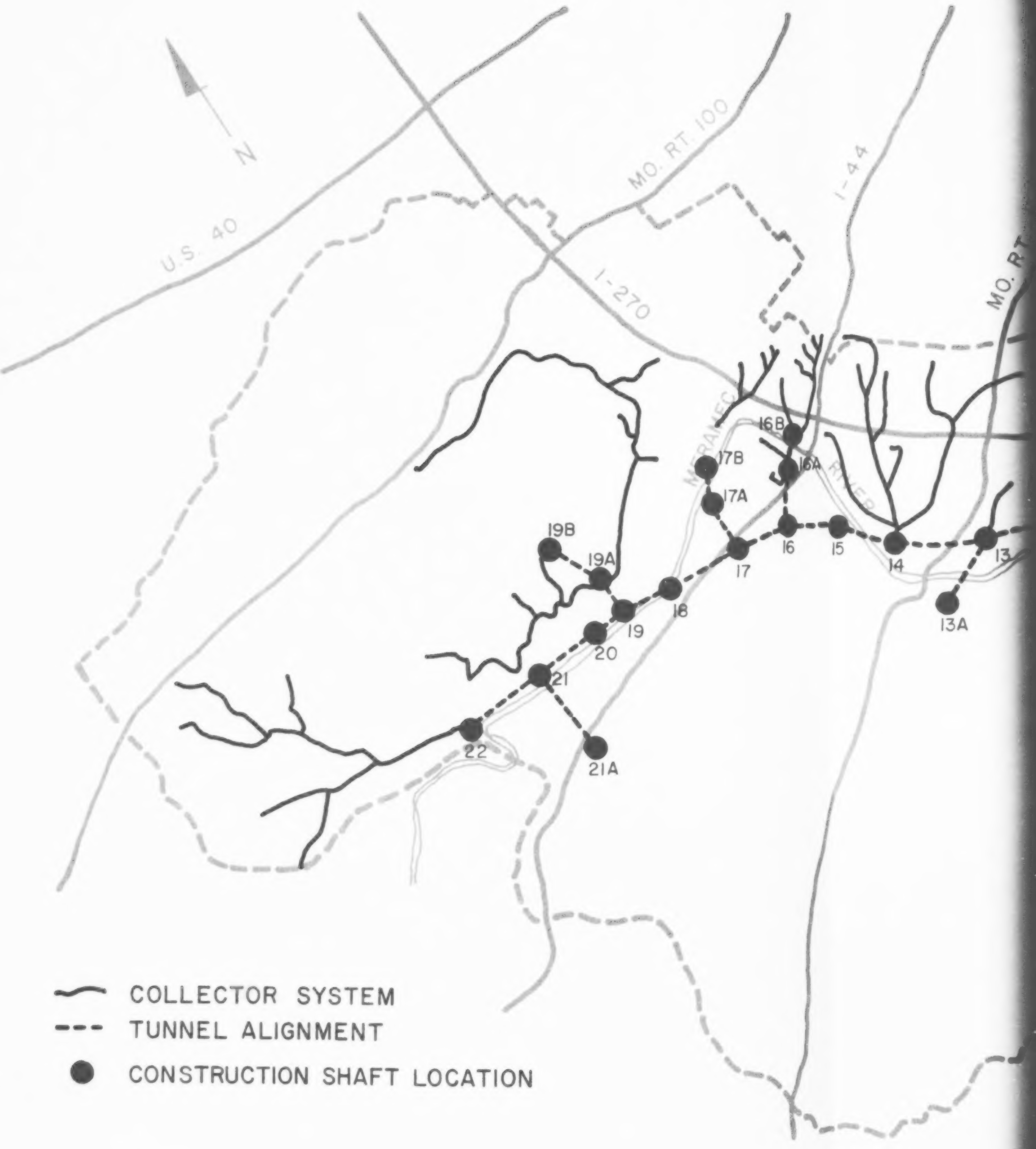
MO. RT. 21
I-55
MISSISSIPPI RIVER

FIGURE 32
REGIONAL ALTERNATIVE
OPEN CUT CONVEYANCE


N
U.S. 40
MO. RT. 100
I-270
I-44
MO. RT.
MERAMEC RIVER
16B
16A
17B
17A
19B
19A
17
16
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13A
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21
22
21A
COLLECTOR SYSTEM
TUNNEL ALIGNMENT
CONSTRUCTION SHAFT LOCATION

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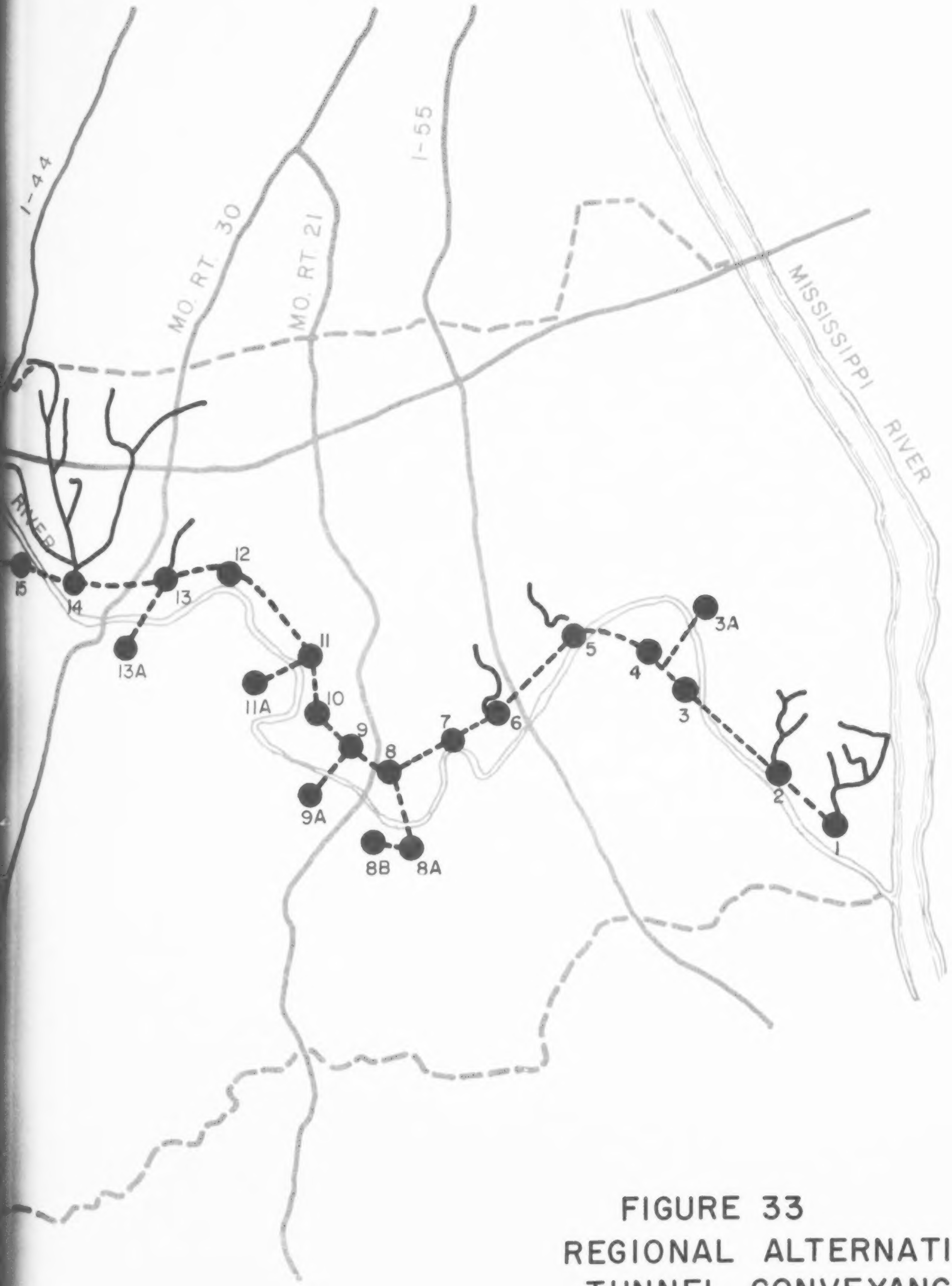
I-44
MO. RT. 30
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I-55
MISSISSIPPI RIVER
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FIGURE 33
REGIONAL ALTERNATIVE
TUNNEL CONVEYANCE

TABLE 45

COST COMPARISON OF ACTION ALTERNATIVES (in millions of 1978 dollars)[a]

Subregional		Regional - Open-cut Conveyance		Regional - Tunnel Conveyance	
Sewage Treatment Plants -	$113	Sewage Treatment Plant -	$ 31	Sewage Treatment Plant -	$ 31
Sub-watershed Collection Systems	21	Sub-watershed Collection Systems -	21	Sub-watershed Collection Systems -	21
		Open-cut Conveyance System -	64	Tunnel Conveyance System	57
Total	$134	Total	$116	Total	$109

NOTE: [a] All costs except for sub-watershed collection system include present-worth costs of operation and maintenance as well as construction costs. Engineering costs are not included.

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Rough cost estimates for these alternatives have been developed throughout the screening process to levels of detail commensurate with plans at the given stage. The estimates in Table 45, for example, were prepared for the Screening of Major Alternatives stage rather than for a more detailed planning or construction stage. The degree to which more detailed cost estimates can be expected to vary from costs in Table 45 is illustrated by the more refined estimates for the regional system with tunnel conveyance included in the 1978 draft report (097). In the more refined estimates, which include many considerations omitted from earlier estimates, the current total construction cost of the system was estimated at $130 million as opposed to the approximately $95 million estimate for construction in Table 45. This illustrates that as additional detail is included in design plans, the overall costs of these alternatives may be expected to escalate. However, the remaining cost elements apply to all three alternatives equally (escalation costs for phasing, engineering costs, operation and maintenance costs for collection systems, etc.). As a result, the costs of the plans will increase in equal proportion through more detailed stages of cost estimation. Based on this assumption, the following general statements regarding the costs of the three alternatives may be made:

1) Total capital costs (construction costs) will be lowest for the subregional system; construction costs for the two regional alternatives will be quite similar to each other.

2) Operation and maintenance costs will be highest (by a large margin) for the subregional system and lowest for the regional system with tunnel conveyance

3) Total costs over the life of the project slightly favor the regional alternative with tunnel conveyance

4) The local share of costs (10% of capital cost plus operation and maintenance cost) will be significantly lower under the regional-tunnel alternative.

The Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) and the 1977 amendments to this Act (PL 95-217) establish a construction grant program whereby municipalities and/or responsible public agencies can obtain federal assistance to pay for 75 percent of the "eligible" costs (as defined by the Act) of water pollution abatement facilities.

The Metropolitan St. Louis Sewer District would qualify as an acceptable applicant for federal grant funds and the great majority of the estimated costs of the three alternative systems would be considered eligible costs.

The State of Missouri also administers a program of financial assistance similar to the federal program. Participation is equal to 15 percent of total eligible costs. With both federal and state grant funds, MSD should be able to obtain nearly 90 percent of the total design and construction costs of the improvements recommended under any of the three alternatives. The remaining 10 percent of the design and construction costs would be borne locally.

The costs of operating and maintaining the facilities and the financing of bonds are not "grant-eligible" and would also be borne locally.

The 201 Facilities Plan for this project uses the following set of assumptions to determine the per household cost of the regional plan with tunnel conveyance:

1) The regional system is complete and all sub-watersheds in St. Louis County and the City of Arnold are connected to it.

2) The system is handling an average daily flow of 27 MGD, of which 20 MGD is base flow for which users can be charged.

3) Costs are at 1978 price levels and consist of: a) general administrative expenses, b) operation, maintenance, equipment replacement, and debt service on interceptor sewers in sub-watersheds, the conveyance tunnel, and the regional treatment plant, and c) debt service costs on interim treatment facilities.

4) Debt service costs are based on the amortization, with a 20 percent coverage of 25 year bonds paying 6 percent interest, issued in the amount of the 10 percent local share of grant eligible capital costs.

5) The total assessed valuation of the service area in St. Louis County is $650 million (as compared to $468 million in 1978.

These assumptions are based on a design scheme which would produce the required treatment levels and on tables from "A Guide to the Selection of Cost-Effective Wastewater Treatment Systems" (USEPA, July 1975).

The per household cost of implementing the regional system with tunnel conveyance, as developed in the 201 Plan, is approximately $40 a year, $24 of which would go toward treatment costs and $16 of which would go toward the financing of bonds and general MSD administrative costs.

Cost comparison supplements to the 201 Plan outline the costs of components of the other alternatives. The per household cost of the other alternatives were developed by using: 1) the component costs; 2) a methodology similar to that used in developing costs for the regional alternative with tunnel conveyance; and 3) a set of assumptions similar to those used in assessing the treatment, financing of bonds and administrative costs of the regional system with tunnel conveyance. These costs are approximately $55 per year under the subregional alternative and $62 per year under the regional alternative with conveyance by open-cut construction. Thus, although construction costs for the regional alternative with tunnel conveyance are higher than under the other two alternatives, the much lower operation and maintenance costs associated with this alternative will result in lower annual costs to the typical residential customer.